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General Recommendations on Fatigue Risk Management for the Canadian Forces

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Defence R&D Canada
Technical Report
DRDC Toronto TR 2010-056
April 2010

Canada

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Abstract

A recent Advisory Publication (ADV PUB Number ASMG 6000, 7 Jan 2010) on Fatigue Countermeasures in Sustained and Continuous Operations recommended that all Air and Space Interoperability Council (ASIC) nations should have national policies regarding fatigue management. Currently, there is no existing doctrine and training program for fatigue risk management available in the Canadian forces (CF). The focus of this document is on the management of sleep hygiene and circadian entrainment, rather than physical, muscle fatigue, or fatigue at the cellular level. Recommendations for fatigue management are based on best practices derived from the latest scientific findings and the collation of appropriate common policies from other military forces that will enable aircrew to perform at their best. It includes a series of summaries that address what is and what is not known regarding the efficacy, implementation and limitation associated with fatigue countermeasures commonly employed. A stratified approach is adopted to ensure that promotion of sleep is the first priority under routine fatigue management, followed by generally approved pharmacological intervention. Employment of those prescription medications permitted by CF policies will be suggested only as a last resort. This document is written primarily for the Air Force; however, the general recommendations to fatigue risk management also apply to the Navy and the Army as they, too, experience sleep loss due to changing time zones and changing operational schedules. The intended key users for these recommendations include commanders, unit trainers, mission planners, medical officers, unit safety officers, and all personnel who support operations. They are well advised to familiarize themselves with the causes of fatigue and the various options in fatigue risk management. This guide is considered to be a “living” document. The material will be updated as new technological information and empirical scientific data emerge.

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Résumé

Dans un récent document consultatif (Numéro ADV PUB ASMG 6000, 7 janvier 2010) portant sur les Mesures contre la fatigue dans les opérations soutenues et continues, on a recommandé que tous les pays membres du *Air and Space Interoperability Council (ASIC)* adoptent des politiques concernant la gestion de la fatigue. Actuellement, il n’existe pas de doctrine ni de programme de formation pour la gestion des risques liés à la fatigue au sein des Forces canadiennes (FC). Le présent document porte essentiellement sur la gestion de l’hygiène du sommeil et l’entraînement circadien et non sur la fatigue physique et musculaire ou la fatigue au niveau cellulaire. Les recommandations liées à la gestion de la fatigue sont basées sur les pratiques exemplaires déterminées par les plus récentes découvertes scientifiques ainsi que sur le dépouillement des politiques courantes des forces militaires d’autres pays, qui permettront au personnel navigant de donner le meilleur d’eux-mêmes. Le document comprend un ensemble de résumés indiquant ce qu’on sait et ce qu’on ne sait pas en ce qui concerne l’efficacité et la mise en œuvre des mesures de lutte contre la fatigue les plus couramment utilisées ainsi que les limites connexes. Une approche stratifiée est adoptée afin que la promotion du sommeil soit la première priorité dans le cadre de la gestion courante de la fatigue, suivie par l’intervention pharmacologique généralement approuvée. L’emploi des médicaments sur ordonnance permis par les politiques des FC sera suggéré uniquement en dernier recours. Le document est rédigé principalement pour la Force aérienne. Cependant, les recommandations générales sur la gestion des risques liés à la fatigue s’appliquent également à la Marine et à l’armée de terre, car elles sont aussi confrontées à la perte de sommeil à cause des changements de fuseaux horaires et de calendriers opérationnels. Ces recommandations sont notamment destinées aux principaux utilisateurs suivants : les commandants, les instructeurs d’unité, les planificateurs de missions, les médecins militaires, les officiers de sécurité de l’unité, et tous les membres du personnel qui appuient les opérations. Ils sont invités à se familiariser avec les causes de la fatigue et les diverses options en matière de gestion des risques liés à la fatigue. Ce guide est considéré comme un document évolutif. Son contenu sera mis à jour à mesure qu’apparaissent de nouveaux renseignements techniques et de nouvelles données empiriques scientifiques.

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Executive summary

General Recommendations on Fatigue Risk Management for the Canadian Forces:

Bob Cheung; Oshin Vartanian; Kevin Hofer; Fethi Bouak; DRDC Toronto TR 2010-056; Defence R&D Canada – Toronto; April 2010.

Background: Fatigue and loss of sleep can affect physical and mental performance. These are some of the critical issues for military planning and operations during war and peace. This document provides a general recommendation on fatigue risk management for the Canadian Forces (CF) and is written primarily for the Air Force; however, the general recommendations on fatigue risk management also apply to the Navy and the Army. The intended key users for these recommendations include commanders, unit trainers, mission planners, medical officers, unit safety officers, and all personnel who support operations.

Results: Our recommendations are based on best practices derived from the latest scientific findings and the collation of appropriate common policies from other military forces that will enable aircrew to perform at their best. It includes a series of summaries that address what is and what is not known regarding the effectiveness and limitation associated with fatigue countermeasures commonly employed.

Significance: Currently, there is no existing doctrine and training program for fatigue risk management available in the CF. This document serves as a guide to all personnel within the CF who experience fatigue due to sleep loss, changing time zones and changing operational schedules.

Future plans: This guide is considered to be a "living" document. The material will be updated as new technological information and empirical scientific data emerge.

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Sommaire

Recommandations générales sur la gestion des risques liés la fatigue pour les Forces canadiennes

Bob Cheung, Oshin Vartanian, Kevin Hofer, Fethi Bouak; RDDC Toronto TR 2010-056; R & D pour la défense Canada – Toronto; Avril 2010.

Introduction ou contexte : La fatigue et la perte de sommeil peuvent affecter le rendement physique et mental. Voici certaines des questions critiques qui se posent pour la planification militaire et opérationnelle en temps de paix et en temps de guerre. Ce document présente des recommandations générales sur la gestion des risques liés à la fatigue pour les Forces canadiennes (FC), et il est écrit essentiellement pour la Force aérienne; cependant, ces recommandations générales s'appliquent également pour la Marine et l'Armée de terre. Les recommandations sont notamment destinées aux principaux utilisateurs suivants : les commandants, les instructeurs d'unité, les planificateurs de missions, les médecins militaires, les officiers de sécurité de l'unité, et tous les membres du personnel qui appuient les opérations.

Résultats : Nos recommandations sont basées sur les pratiques exemplaires déterminées par les plus récentes découvertes scientifiques ainsi que sur le dépouillement des politiques courantes des forces militaires d'autres pays, qui permettront au personnel navigant de donner le meilleur d'eux-mêmes. Elles comprennent un ensemble de résumés indiquant ce qu'on sait et ce qu'on ne sait pas en ce qui concerne l'efficacité des mesures de lutte contre la fatigue les plus couramment utilisées ainsi que les limites connexes.

Importance : Actuellement, il n'existe pas de doctrine ni de programme de formation pour la gestion des risques liés à la fatigue au sein des Forces canadiennes (FC). Le présent document sert de guide pour tout le personnel des FC exposé à la fatigue due à la perte de sommeil, au changement de fuseaux horaires et au changement de calendriers opérationnels.

Perspectives : Ce guide est considéré comme un document évolutif. Son contenu sera mis à jour à mesure qu'apparaissent de nouveaux renseignements techniques et de nouvelles données empiriques scientifiques.

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Acknowledgements

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1 Introduction

"My mind clicks on and off. I try letting one eyelid close at a time while I prop the other with my will. But the effect is too much, sleep is winning, my whole body argues dully that nothing, nothing life can attain is quite so desirable as sleep. My mind is losing resolution and control."

By Charles Lindbergh about his 1927 transatlantic flight.

According to the Concise Oxford Dictionary of Current English, fatigue can be explained as "Weariness after exertion; reduction of efficiency of muscle, organ, etc. after prolonged activity, task, etc." In current literature on fatigue risk management in operations, there is no consensus for a single definition of fatigue. Fatigue in operations can be described as a complex internal state that affects both physiological activity and subjective feelings. It is directly related to time of continuous wakefulness and is characterized by tiredness, a lack of alertness, and reduced mental and physical performance, often accompanied by drowsiness. Clearly, there is an interaction between physical and mental fatigue, as they are not mutually exclusive of each other. However, fatigue can manifest itself as a result of many factors. Therefore, a clear and concise definition of fatigue is not possible given its multifaceted nature. It should be noted that this document addresses fatigue that is primarily caused by inadequate rest, circadian disruption, and changing operational tempo. Because fatigue is a significant factor in terms of performance degradation, the challenges related to it must be dealt with and planned for in order to maximize performance and mission success.

A recent Advisory Publication (ADV PUB Number ASMG 6000, 7 Jan 2010) on Fatigue Countermeasures in Sustained and Continuous Operations was completed by the Air & Space Interoperability Council (ASIC) under Aerospace Medical Group project - ASMG09B. It recommends that all ASIC nations should have national policies in place regarding fatigue management. Whilst details of national policies will vary, it is essential that policy implementation begin with education and training at all levels of the organization. Education and training materials should provide information on the dangers of fatigue, the physiological and behavioural mechanisms that underlie fatigue, the causes of sleepiness, the importance of sleep, and proper sleep habits within the operational context. It should also address some of the misconceptions about fatigue, and make specific recommendations on fatigue risk management and countermeasures. The focus of this document is on the management of sleep hygiene and circadian entrainment, rather than physical, muscle fatigue, or fatigue at the cellular level that renders an individual's ability to function normally through excessive physical stimulation or prolonged physical exertion and environmental influences.

Currently, there is no existing doctrine and training program for fatigue risk management available in the Canadian Forces (CF). The extent of any education is limited to a lecture on circadian entrainment at the Basic Flight Surgeons Course level. There is a wealth of information regarding fatigue and alertness management strategies in civil transportation/work force and among our allied forces. There has also been extensive scientific research in the last 60 years on sleep, sleep deprivation, circadian rhythms, and the effects of theses factors on alertness and performance. Therefore, the objectives of this document are:

1. To establish recommendations for fatigue management based on best practices derived from latest scientific findings and the collation of appropriate common

policies from other military forces that will enable aircrew to perform at their best. It includes a series of summaries that address what is and what is not known regarding the efficacy, implementation and limitation associated with fatigue countermeasures commonly employed.

2. To create a common culture within the CF organization whereby quality and duration of sleep are routinely optimized through the evidence-based scheduling of duty/rest periods, and improvements to the sleep environment.

A stratified approach is adopted to ensure that promotion of sleep is the first priority under routine fatigue management, followed by generally approved pharmacological intervention. Employment of those prescription medications permitted by CF policies will be suggested only as a last resort. Finally, a summary on fatigue countermeasures that are currently under investigations is also presented. This information was attained through an extensive literature search and review, utilizing open scientific literature and various guides and recommendations from our allied military forces and advisory publications from ASIC. The scientific literature reviewed and cited in this report is found in the Reference section; recommended reading about fatigue management from our allies can be found in the Bibliography section. Correspondingly, in-depth scientific information is attached in the Appendices.

Flying demands the highest performance and safety standards. It is characterized by intense and sustained workloads, and rapid cognitive demands. The necessity of flying at night, in different time zones, and constantly rotating work schedules also contribute to potential performance degradation. Therefore, this document is written primarily for the Air Force; however, the general recommendations to fatigue risk management also apply to the Navy and the Army as they, too, experience sleep loss due to changing time zones and changing operational schedules. The intended key users for these recommendations include commanders, unit trainers, mission planners, medical officers, unit safety officers, and all personnel who support operations. They are well advised to familiarize themselves with the causes of fatigue and the various options in fatigue risk management. This guide is considered to be a “living” document. The material will be updated as new technological information and empirical scientific data emerge. It is our intention to produce customized recommendations to specific operational mission profiles; other Special Forces requirements will be addressed in successive documents at a later stage after consultation with the line communities and further research in identified areas.

2 The Complexity of Fatigue

For the purpose of this document, we loosely define "sustained operations" as those that continue beyond twenty-four hours until mission objectives are met. Sleep deprivation is common during sustained operations. "Continuous operations" can be defined as operations that extend over 24 hours at a normal rate; they do not necessarily involve longer hours per individual, although they may involve shift work that may conflict with the circadian rhythm and cause less efficient (or intermittent) sleep.

2.1 Physiological fatigue

Fatigue includes physiological fatigue as a result of prolonged physical work, continuous operations, acute and cumulative sleep deprivation, sleep disruption, sudden changes in work/rest schedules, split shift work schedules, misalignment between the human circadian rhythms (body clock) and the local time (jet lag), the double burden of shift work (shift lag) and jet lag with irregular and unpredictable exposure to light and darkness, exposure to a harsh environment (noise, extreme temperature, hypoxia), poor physical conditioning, and inadequate nutrition and fluids.

In general, extreme temperatures (hot or cold), humidity, altitude, whole body vibration and acoustical noise can indirectly contribute to operator fatigue. Excessively hot conditions (above 30°C) can cause an operator to feel less alert and generally experience more fatigue. Specifically, working under hot and humid (80%) weather is significantly more detrimental to worker performance than hot and dry conditions, and makes one feel fatigued sooner (Nybo and Nielsen, 2001). High altitude reduces oxygen concentration and can lead to a general sense of fatigue (Van Lunteren et al., 1997). Whole body vibration and acceleration (extending up to 100 Hz) can add to the operator's general feeling of fatigue (Adamol et al., 2002). Physiological fatigue at the muscle, metabolic and cellular level is beyond the scope and objective of this document and will not be dealt with here.

2.2 Mental fatigue

Mental fatigue can be defined as a psychological state caused by prolonged periods of demanding mental activity/stress, extended periods of anxiety, and long durations of boring monotonous tasks. Prolonged periods of stress and anxiety may lead to difficulty falling or staying asleep and poor quality of sleep or sleep deprivation in general. In turn, poor sleep or sleep deprivation will lead to increased fatigue and decreased performance. In the manual "Flight Safety for the Canadian Forces" (A-GA-135-001/AA-001), it is stated that:

> *"Mental fatigue occurs when the effects of fatigue impair the individual's cognitive performance. Many tasks/missions performed in aviation require an individual(s) to process large amount of information in a short period of time and to do this on a continuous basis. An individual's ability to do this can be reduced by beginning the task without the appropriate amount of rest. Likewise, the continuous information processing required during sustained operations can deteriorate an individual's ability to perform a task. Given the high operational tempo experienced by most individuals involved with*

military aviation, mental fatigue can be common under certain circumstances. This can occur, for example, when a maintenance technician or pilot sleeps for only a few hours the night before a task/mission or when an air traffic controller is required to control a large volume of air traffic over a period of several hours."

2.2.1 The effect of sleep deprivation on cognitive performance

An extensive literature exists on the effect of fatigue on cognitive performance in professions that are characterized by reduced and unpredictable sleep cycles (e.g., medical interns, shift workers, etc.). A review of this literature highlighted three points about fatigue induced by sleep deprivation in laboratory studies (Samkoff & Jacques, 1991):

1. Fatigue did not impair performance on brief psychomotor tests measuring manual dexterity, reaction time, and short-term memory.

2. Fatigue did impair performance on routine, repetitive tasks requiring vigilance.

3. Fatigue adversely affected mood.

This literature suggests that fatigue induced by sleep deprivation does not necessarily have a uniformly negative effect on cognitive function. However, it should be noted that there are relatively few empirical studies on how psychological factors such as anxiety and stress can lead to measureable increments in fatigue, and decrements in performance.

2.2.2 Effect of mental fatigue on cognitive performance

Although very little is known about the effect of mental fatigue on physical performance (but, see Marcora et al., 2009), the effect of mental fatigue on cognitive performance has been studied extensively. The effects of fatigue on psychological function are mediated by variations in brain function (Boksem & Tops, 2008). Specifically, there is a large body of literature on the effect of mental load on cognitive performance, which itself is limited by working memory capacity. Working memory is conceived as a dedicated system that maintains and stores information in short term memory, which, in turn, is utilized to perform human thought processes (Baddeley, 2003). While various versions of this theory exist, they all share the feature that human cognitive processing is limited by working memory capacity - both in terms of information storage as well as processing. Within this literature, working memory load is considered to be manipulated by engagement in demanding (or multiple) cognitive activities. This, in turn, is hypothesized to "deplete" working memory resources. The effects of this depletion can be registered objectively in the form of performance decrements (e.g., taking more time to complete task, reductions in accuracy), or subjectively through feelings of tiredness. Further detail on the characteristics of working memory, fatigue, and cognitive performance is given in the **Annex A**.

2.3 Contributing factors to fatigue in operations

***Increased operational tempo* -** As mentioned previously, fatigue generated by operational requirements can degrade human performance capability and reduce the safety margin. For example, during increased operational tempo and the likelihood of around-the-clock operations, ground crews such as aircraft maintenance personnel are more vulnerable to fatigue than the aircrew. They generally do not have the regulated work/rest schedules that govern aircrew/pilot operations. Depending on the operational demands, their shifts can be extended and night shift is common. Their duties are technical, labour-intensive, and highly regulated tasks that require high order cognitive abilities and mental concentrations that are in turn susceptible to fatigue.

***Using night vision devices (NVD)* -** There are a number of inherent factors that can contribute to increased fatigue when using NVD. For example, the overall weight of the device, eye strain due to reduced acuity, contrast, reduced depth perception, inability to adjust to binocular disparity, and optical distortion may all contribute to fatigue. Limited field-of-view would necessitate increased head movements, and with an increased weight on the helmet, it could contribute to head and neck strain and fatigue. Although the overall weight of NVD has been reduced with current advances in technology, complaints of neck and eye strain, and deterioration of psychomotor skills are common. In addition, an obvious factor that has often been overlooked is that NVD are used at night, during the body's circadian trough. It is not clear whether fatigue associated with NVD use is associated with the device itself or whether there is an additive effect or interaction with the circadian factor.

2.3.1 Fatigue can be classified into:

1. Acute Fatigue, which can be due to physical exertion or sleep loss and can be alleviated by a single rest or sleep period. In the manual "Flight Safety for the Canadian Forces" (A-GA-135-001/AA-001), the examples given for acute fatigue include the lack of, or low quality of, sleep the night before a task/mission, and also the importance of circadian rhythm effects.

2. Chronic Fatigue, which can be due to either medical or psychological illness and is unrelieved by a single rest or sleep period. In the manual "Flight Safety for the Canadian Forces" (A-GA-135-001/AA-001), the examples given for chronic fatigue include sleep debt accumulated over a period greater than 48 hours, and also the importance of circadian rhythm effects.

3. Cumulative fatigue builds up across work and duty periods when there is inadequate recovery (due to inadequate sleep) between duty periods. Recovery from cumulative fatigue can not be accomplished with one good quality nocturnal sleep.

2.3.2 The signs and symptoms of fatigue:

- Vacant stare with sunken bloodshot eyes
- Eye strain, dim and blurred vision
- Paleness of skin
- Slurred speech
- Slowed responsiveness/reaction time
- Lowered body temperature
- Lowered heart rate
- Headaches

- Dizziness
- Apathy
- Lethargy
- Drowsiness
- Unstable posture
- Intermittent loss of muscular strength, stiffness
- Loss of manual dexterity/difficulty making fine movements

2.3.3 The consequences of fatigue:

Although fatigue cannot be directly measured, the initial effects often go unnoticed by the individual, and the impact of fatigue on performance is often underestimated. Fatigue can lead to:

- Lapses in attention
- Loss of vigilance
- Impaired judgement
- Impaired reasoning and decision-making
- Impaired problem solving
- Delayed reactions
- Loss of short term memory
- Reduced situational awareness
- Diminished crew coordination
- Tendency to abbreviate or skip routine checks, accepting “short cuts”
- Increasing frequency of errors of omission
- Low motivation to perform “optional” activities
- Loss of emotional controls
- Irritability and impatience
- Poor assessment of risk
- Failure to appreciate consequences of action
- Measurable changes in performance
- Micro sleep (falling asleep inadvertently in 10 seconds or less)

It should be emphasized that the deleterious effects of fatigue do not appear to be easily mitigated by training and experience. The wide range of effects listed above can erode the safety margins in operational settings and lead to incidents, accidents and mission failures.

2.4 Qualitative similarities in cognitive performance degradation due to fatigue and intoxication

The current federal BAC (blood alcohol concentration) legal limit is 0.05% (50 mg of alcohol/100ml of blood). Drivers with BACs in the range of 0.05% to 0.08% are 7.2 times more likely to be involved in a fatal crash than drivers with a zero BAC (Murie, 2007). It has been demonstrated that there are qualitative similarities in cognitive impairment associated with 24 hours of sustained wakefulness and a BAC of 0.05 – 0.1% (Dawson & Reid, 1997; Williamson & Feyer, 2000; Williamson et al., 2001; Falleti et al., 2003.) Specifically, fatigue caused greater impairment than alcohol on continuous attention, memory, learning, and accuracy of complex matching task. Alcohol was more detrimental than fatigue on accuracy in memory and learning tasks (Falleti et al., 2003). It was suggested that 17 hours of continuous wakefulness degraded aspects of performance to the same extent as a BAC of 0.05%, the proscribed level of alcohol intoxication in many countries. After 24 hours of wakefulness, performance is reduced to an equivalent of 0.10% BAC (Caldwell, 1999). The mean relative performance levels against sustained wakefulness and BAC are illustrated in *Figure 1*. The performance in sustained wakefulness condition expressed as mean relative performance, and the percentage blood alcohol concentration is shown in *Figure 2*.

2.5 Consequences of fatigue

As mentioned above, loss of alertness associated with human fatigue is a significant factor contributing to the decrease in mission effectiveness and the increase in aircraft incidents/accidents. According to Transport Canada and the US National Transportation Safety Board (NTSB), the incidence of fatigue is underestimated in virtually every transportation mode because of difficulties associated with the quantification and measurement of fatigue. Decreased performance related to sleep loss and circadian disruption has been implicated in some major disasters in the civilian world. For example, analyses of the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska, the 1984 toxic gas leaks in Bhopal, India, and the 1979 partial core meltdown in Three Mile Island Nuclear Generating Station in Pennsylvania have all suggested that fatigue was one of the contributing factors (Rosekind et al., 1994a) to the mishaps.

The effect of sleep restriction on performance (using the psychomotor vigilance task) is illustrated in the *Figure 3*. As the number of hours of sleep decreases across days, performance decreases correspondingly.

2.5.1 The distribution of accidents during various phases of flight

As shown in *Figure 4* and *Figure 5*, 55.8% of accidents happen in the last 15% of the flight time. In long haul flights (such as those by the CF Air Transport Group [ATG]), the last 15% of the flight (initial approach, final approach and landing) arrives at the end of a 10 - 12 hour working day.

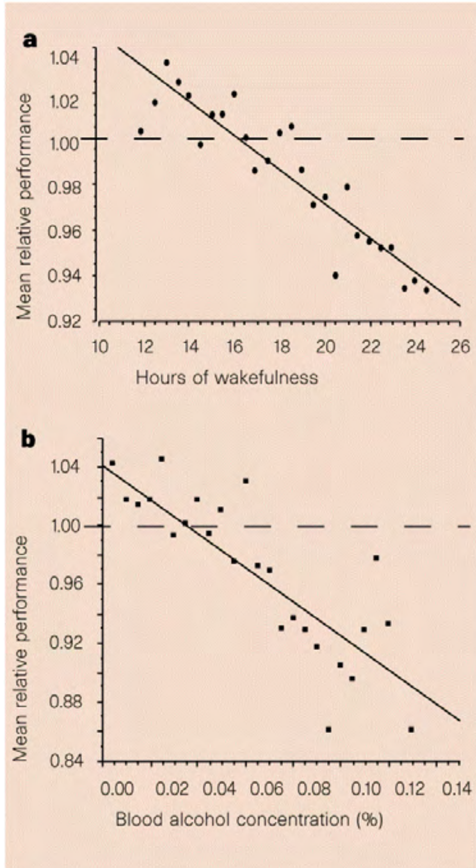

Figure 1: Mean relative performance levels against (a) time of sustained wakefulness up to 26th hour and (b) BAC up to 0.14% (Dawson & Reid, 1997).

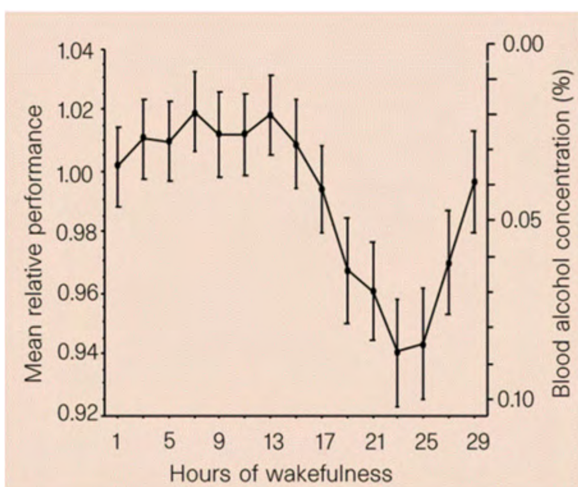

Figure 2: Performance in sustained wakefulness condition expressed as mean relative performance and the percentage BAC equivalent (Dawson & Reid, 1997).

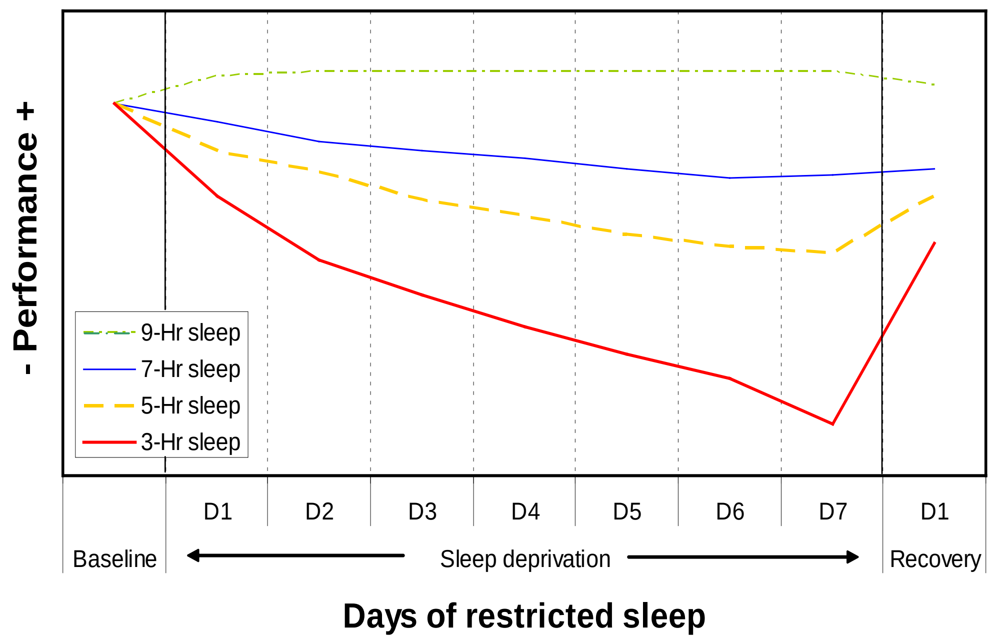

Figure 3: Mean psychomotor vigilance task speed across days as a function of time in bed (adapted from Belenky et al., 2003)

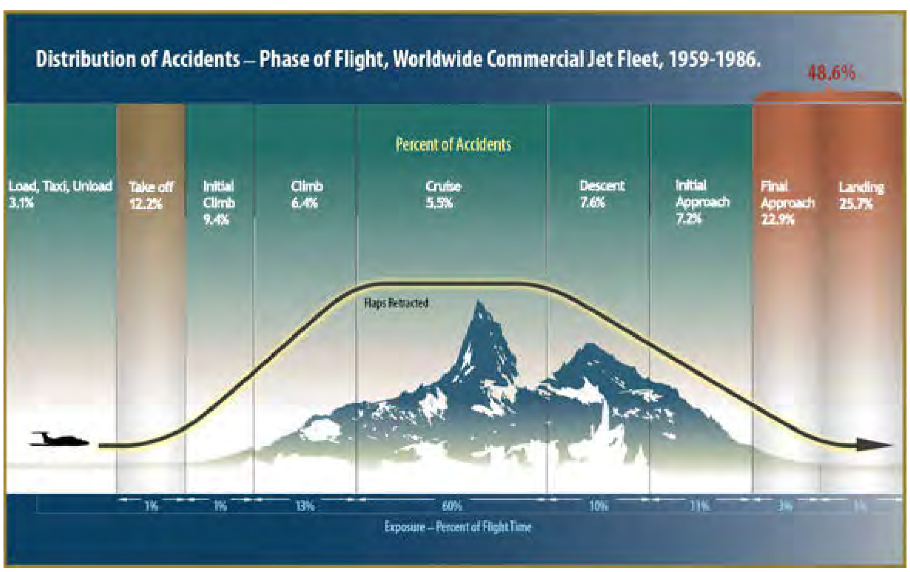

Figure 4: Distribution of accidents (Flight Comment 2009 Issue 2).

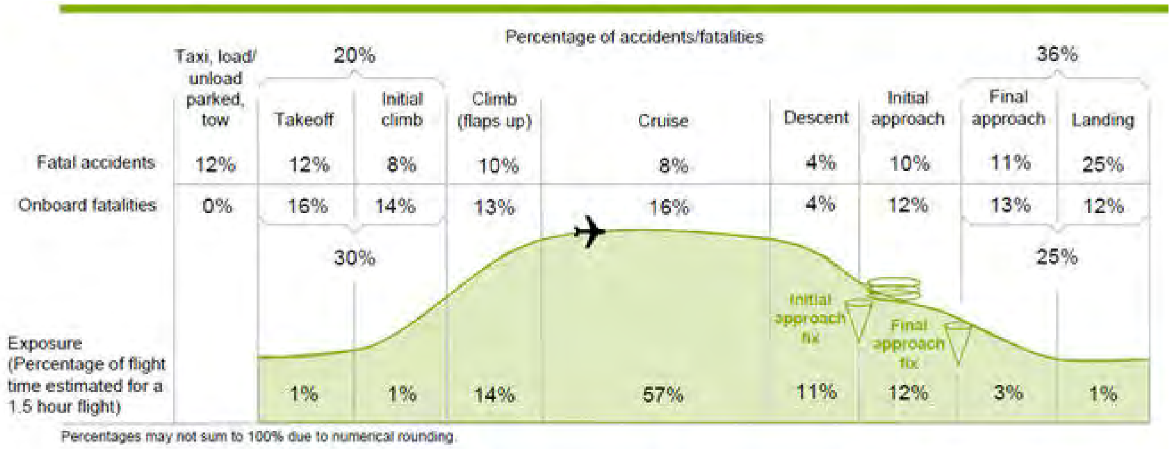

Figure 5: Distribution of accidents. Source: Statistical Summary of Commercial Jet Airplane Accidents, 1959 - 2008, Boeing

2.6 Examples from the CF Directorate of Flight Safety illustrating fatigue as a contributing factor to flight safety:

Example 1: DFS – Flight Comment, September -October 1964 – Two vital oil caps were improperly installed recently resulting in a "close call" for the crew of a four-engine aircraft. The man who made the mistake had performed this routine job many times before and yet a near-disastrous error was made. Why? The error had been committed by a well-motivated man but under fatigue-inducing circumstances away from base in very adverse weather - on a special maximal-effort type exercise.

Example 2: CF Flight Safety Investigation Report, November 2005 – A recent incident involved a CF CC130 Hercules during a shallow tactical departure. The crew made a navigation error and went off-track. To rejoin their planned route the crew elected to enter a valley on their left and climb to a minimum safe altitude in order to cross the ridge along the edge of the valley. However, it soon became evident that the ridges could still not be cleared. After several risky manoeuvres the crew managed to exit the valley without further incident and proceeded to their destination. The Flight Safety Investigation committee determined that the navigation error was made due to, among other human factors, acute and chronic fatigue. The crew flew their mission in a fatigued state (see *Table 1* below).

Table 1: Sleep duration and fatigue.

Prior Sleep	**Sleep duration by position** (hours)			
	AC	**FO**	**Nav**	**FE**
Accrued sleep **24 hours** before incident	4	2	12	4.5
Accrued sleep **48 hours** before incident	9	8	22	7.5

AC is captain; FO is first officer; Nav is Navigator; FE is flight engineer

Aircrew testimonial suggests that adequate quality sleep had been compromised due to individuals experiencing difficulty in adapting to the conditions of camp life. Additionally, the change in timing to an early morning launch necessitated that the crew readily re-adjust their circadian rhythm. These factors resulted in insufficient sleep attainment by most of the crew.

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3 Background Information on Sleep

Contrary to popular belief, sleep is not a passive state. Rather, it is a complex, active physiological process of rejuvenation that is vital to human survival; it cannot be stored or built up (Roth, 2004; Markov & Goldman, 2006). It is defined as a state of unconsciousness from which a person can be aroused by appropriate sensory stimuli, and is associated with highly organized activities in the body and the brain. Sleep is composed of 4 stages of non-rapid eye movement (NREM) and two phases (tonic and phasic) of rapid eye movement (REM) state (see *Table 3* **Annex B**). There remain many questions unanswered as to why we sleep, how sleep occurs and what happens when we sleep. The normal sleep period refers to the typical 7 - 9 hours of sleep that humans need every night. The actual amount of sleep required and the tolerance to fatigue is individualized (Caldwell et al., 2005). Similarly, the sleep architecture, i.e., the absolute durations and the percentage of time spent in the states, stages and phases of sleep, and their cyclic nature vary between and within individuals (Markov & Goldman, 2006). Therefore, a "one-size-fits-all" sleep/rest schedule is counterproductive. A complete description of the sleep architecture, time spent in the various stages and phases of sleep are listed in *Table 3* in **Annex B**. All stages of sleep are important, and selectively depriving an individual of a particular stage results in a rebound when that stage is permitted, i.e., an increase in time spent in the deprived stage. One can determine one's own individual physiological sleep need by gradually lengthening the sleep period until daytime sleepiness subsides.

Sleep loss is one of the most common causes of fatigue. It may be acute or, if occurring continuously over time, may result in a cumulative sleep debt. Hence, sleep debt can be defined as the accumulation of sleep loss over time. It should be noted that fragmented sleep is less effective in reducing sleep debt than continuous sleep. Furthermore, there is no adaptation to sleep deprivation. As the amount of sleep debt accumulates the corresponding performance proportionally worsens.

It has been suggested that during sustained operations, the minimal amount of sleep to maintain performance is 6 - 8 hours per day (van Housen, 2005). It has also been suggested (US Army) that the normal sleep length can be reduced by 1 - 2 hours for an extended period of time without significantly affecting performance, but once the sleep restriction period ends, soldiers will have to revert back to their normal sleep length. Five hours of sleep per night should be considered to be the absolute minimum for longer term (14 days) operations.

3.1 Major sleep disorders

Clinical sleep disorders are major disturbances of normal sleep patterns that lead to distress and which can disrupt normal functioning during the day (ICSD, 2005). They affect virtually everyone at some point in their lives, and can lead to serious stress and other health consequences. It is helpful for all personnel to recognize and be familiar with some of the major sleep disorders listed below, so that timely mitigation/treatment can be conducted. The international classification of sleep disorders (ICSD) is listed in detail in *Table 4* in **Annex B**.

- Sleep Apnea – pauses in breathing during sleep, associated with loud snoring
- Narcolepsy – inherited disorder, irresistible sleep attacks
- Periodic limb movements – leg jerks or kicks during sleep

- Insomnia - difficulty falling asleep or staying asleep, poor quality sleep, difficulty initiating and maintaining sleep
- Insufficient Sleep Syndrome also called intentional sleep restriction - individuals that treat sleep as an option rather than a requirement

4 Background Information on the Circadian Rhythm (Internal Body Clock)

The word circadian (Latin: circa = about; dies = day) is used to describe biological and behavioural rhythms. The human circadian rhythm or circadian pacemaker regulates physiological and behavioural functions on a 24-hour basis. The specific environmental time cues that synchronize it to a 24-hour day are known by the German term zeitgebers, meaning time givers/time cues. It normally keeps in step with local time because it is sensitive to specific time cues (sunlight and pattern of social activities) from the environment. Its role is to program us on a 24-hour schedule so that we sleep at night, remain awake during the day, and have daily peaks and troughs controlling different functions at specific times (e.g., specific pattern of hormone release, alertness, and core temperature). The best and worst times of day in terms of alertness are determined mostly by light cues, received by the circadian clock.

The primary circadian "clock" in mammals is located in the suprachiasmatic nuclei, a pair of distinct groups of nerve cells located in the hypothalamus of the brain (area just above the brain stem, see *Figure 6* and *Figure 7*). Destruction of the suprachiasmatic nuclei results in the complete absence of a regular sleep/wake rhythm. The retina of the eyes contains light-responsive retinal ganglion cells. These nerve cells, which contain a photopigment called melanopsin, follow a nervous pathway (called the retinohypothalamic tract), leading to the suprachiasmatic nuclei. It appears that the suprachiasmatic nuclei receive information on the lengths of the day and night from the retina, interpret it, and transmit the information on to the pineal gland located near the center of the brain (*Figure 7*), between the two hemispheres, in a groove where the two rounded thalamic bodies join (*Figure 6*). It is the pineal gland that secretes the hormone melatonin that is concerned with biological timing. The secretion of melatonin peaks at night and ebbs during the day and is thereby associated with sleep. The period of melatonin secretion has often been referred to as “biological night”; its presence provides information about the length of the night. Recent research has shown that human subjects can be entrained to slightly shorter (23.5-hour cycle) and longer periods (24.65-hour cycle) than the Earth’s 24 hours (Scheer et al., 2007). Night work or time zone changes can create internal and external desynchronization.

As mentioned briefly above, “circadian” refers to biological and behavioural rhythms regulated by the body clock. The availability of mental and physical resources fluctuates during the 24-hour day. The best and worst times of day are determined mostly by light cues, received by the body clock. Physical and mental energy peaks daily during daylight hours between 0800 and 1200 hours, decays slightly between 1300 and 1500 hours, then increases again between 1500 and 2100 hours, declining again from 2200 through 0600 hours. The normal time of maximal sleepiness is between 0200 and 0500 hours.

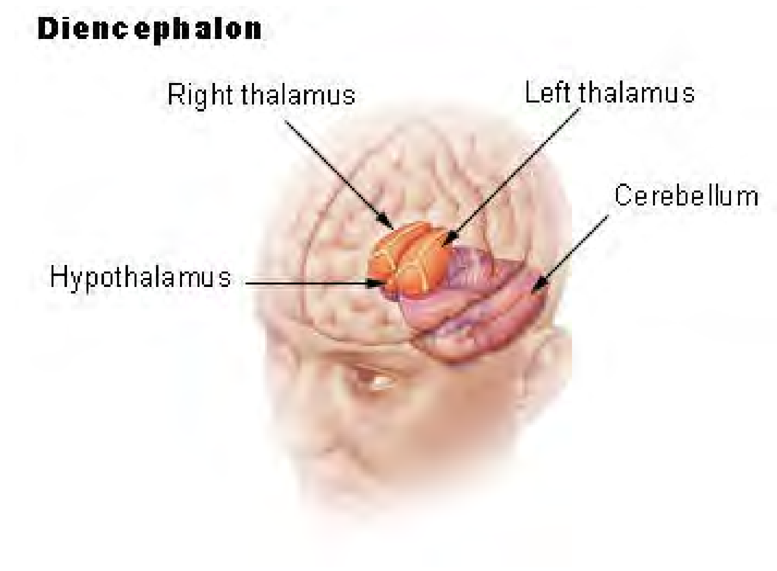

Figure 6: Location of hypothalmus

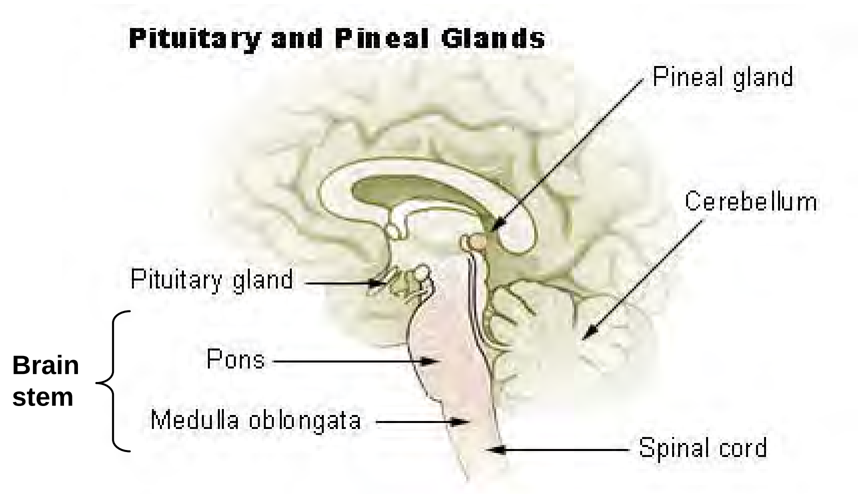

Figure 7: Location of the pineal gland

Figure 8 below (from: McCallum et al., 2005) illustrates the circadian rhythm in several physiological and psychological functions. It should be noted that when alertness is at its lowest (between 2400 and 0500 hours), melatonin levels are at their highest, suggesting that secretion of melatonin by the pineal gland leads to sleep onset.

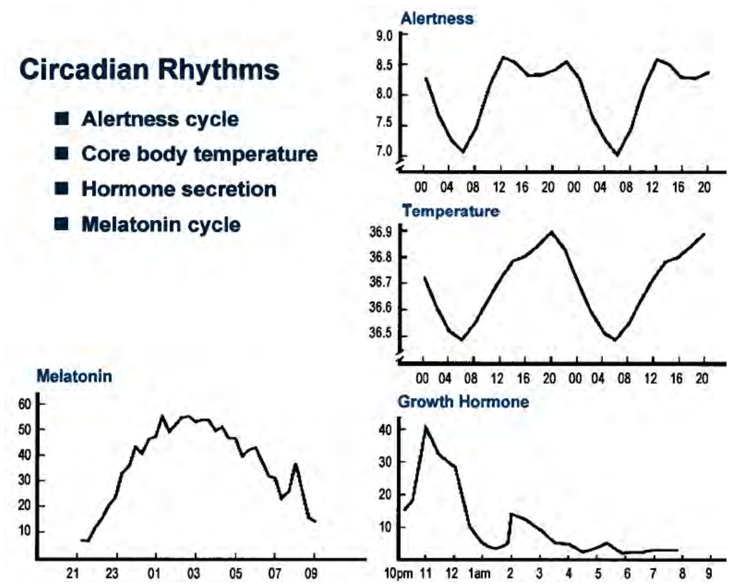

Figure 8: Effects of circadian rhythm on some physiological and psychological functions (McCallum et al., 2005)

When a person suddenly changes to a new duty/rest schedule or flies to a new time zone, the circadian clock cannot adjust immediately, it takes a certain amount of time depending on how extreme is the change. In other words, the circadian clock is out of step with the environment. This is the basis for the circadian disruption associated with jet lag and shift lag. In jet lag, circadian disruption is induced by the change in sunrise and sunset times caused by crossing several time zones. In shift lag, circadian disruption is caused by the change in work and sleep schedule and the discord with normal day/light exposure time. Classic symptoms of circadian disruption include fatigue, malaise, and drowsiness during work periods, lack of motivation, confusion, poor concentration, impaired decision making ability, and digestive disorders. Indicators of circadian disruption (with or without simple fatigue) include:

- Vacant stare
- Glazed eyes
- Pale skin
- Body sway upon standing
- Walking into objects
- Degraded personal hygiene
- Loss of concentration during briefings
- Slurred speech

This lack of consistency in daylight exposure times results in an unpredictable availability of alertness, and cognitive and physical resources. Some individuals appear to be more susceptible to jet lag/shift lag than others. In general, individuals who prefer early-morning rise time (0400 - 0600 hours) and early bed times (2000 - 2100 hours) tend to easily adjust to early morning duty hours. Individuals who prefer to retire at 2200 hours or later and rise after 0700 hours tend to adjust more easily to night time hours than early morning hours (Comperatore et al., 1996).

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5 Fatigue Risk Management

Fatigue risk management can be considered as a collection of guidelines and procedures including approved pharmacological countermeasures that attempt to prevent and deal with the detrimental effects of fatigue and sleep loss on performance. It is important to emphasize that there is no simple, universal solution to fatigue risk management. Different operations pose different demands, and individuals vary widely in their reactions to these demands.

The strategies for fatigue management can be divided into two types (Rosekind et al., 1994a):

1. Preventive strategies are those that should be employed before work and during planned rest periods to ensure optimal alertness and performance. These are designed to encourage and maximize the quality of sleep and minimize circadian disruption.

2. Operational countermeasures are those that are designed to minimize the impact of sleep loss and circadian disruption on alertness and on-the-job performance by providing temporary relief from the symptoms of fatigue.

Based on the aforementioned strategies, and those suggested by the ASIC document, fatigue risk management and countermeasures are discussed under the following categories. It should be noted that as new validated empirical data and changing operational requirement emerge in the future, necessary modifications would have to be made to these recommendations. We have included countermeasures that are adopted by other countries and organizations currently not approved by the CF in terms of information sharing.

5.1 Routine fatigue management

5.1.1 Identify and treat physiological sleep disorders

Existing sleep disorders, if untreated, will lead to chronic sleep deprivation or sleep restriction. As mentioned earlier, a range of physiological sleep disorders exists - sleep apnea, narcolepsy, periodic limb movements, insomnia, and the “insufficient sleep syndrome”. These disorders can disturb the quantity and quality of sleep, and subsequently further degrade alertness and performance. Most sleep complaints can be managed well in a primary care setting with the knowledge of diagnostic considerations and management alternatives.

5.1.2 Minimize sleep loss by maintaining good sleep hygiene

In the document of Flight Safety for the Canadian Forces (A-GA-135-001/AA-001), it is stated that:

> *“Inadequate rest (e.g., when the opportunity for rest was provided but the individual(s) failed to rest appropriately), leads to fatigue and impaired cognitive performance.”*

Sleep hygiene refers to health and behavioural practices and environmental factors that influence quality of sleep (Gellis & Lichstein, 2009). Sleep loss is one of the most common causes of fatigue. Sleep cannot be stored or built up; however, the preload (total amount of sleep loss prior to mission commencement) can be reduced. It is often said that there is no substitute for a good night's sleep. Therefore, the primary recommendation on good sleep hygiene is to obtain adequate sleep prior to the duty period, followed by regular exercise and proper nutrition. Abiding by sleep hygiene practices will lead to good quality sleep that is restful, rejuvenating and restorative; in contrast, poor sleep hygiene practices increase the likelihood of poor sleep that can lead to day time sleepiness. Whenever possible, obtaining a sufficient quantity of high quality sleep on a daily basis should be the main focus in mitigating fatigue (Caldwell & Caldwell, 2009). The quality of sleep has been shown to be enhanced by favourable environmental conditions. This may be difficult to achieve during military operations and should be addressed at an early stage in operational planning. Sleeping accommodations should be single, quiet, dark, and maintained at a comfortable temperature. Eye shades and ear plugs are simple and portable solution to shield off bright light and to reduce noise when sleeping. Whenever possible, those in shared accommodations should have common shifts to minimize disturbances. The results concerning the beneficial effects of alcohol for night time sleep are mixed. Alcohol consumption did not differentiate good sleepers from poor sleeper (Cheek et al., 2004; Gellis & Lichstein, 2009), although poor sleepers tend to consume more alcohol (Jefferson et al., 2005; Johnson et al., 1998). Nevertheless, alcohol should not be used as a sleep aid. Although it induces drowsiness, it disrupts the sleep architecture, resulting in easily disturbed, lighter sleep. Alcohol consumption in conjunction with sedative use will amplify the effect of the sedative and is contraindicated (inadvisable). Exercise and stimulants including caffeine and nicotine should be avoided before planned sleep/rest periods. A self-report Sleep Hygiene Practice Scale (SHPS) (Yang et al., 2010) that lists the different activities which counteract good sleep hygiene is attached in *Table 5*, **Annex B**.

5.1.2.1 Recommendations for maintaining good sleep hygiene and habits

1. Avoid intentional sleep restriction. The mean number of lapses in vigilance task performance increases significantly with chronic sleep restriction (Johnson et al., 2004).

2. Ensure sufficient daily sleep. If drowsiness occurs during daytime or when engaging in activities, evaluate the amount of sleep each night and adjust accordingly.

3. Optimize available sleep opportunities.

4. Keep consistent wake-up and bed times every day including weekends.

5. Do not take naps during a routine day (when 8 hours of sleep is available in a good environment).

6. Keep consistent "getting ready for bed" routine as often as possible.

7. Associate environment with sleep, i.e., use bed and bedroom for sleep, rather than for watching TV, etc.

8. Ensure quiet and comfortable setting for sleep environment and, when possible, sleep in complete darkness and avoid even momentary exposure to sunlight during the sleep period. Reduce sunlight in all living areas during sleep periods (including washrooms).

9. Sleeping quarters should isolate night-shift personnel from the activity of day-shifters to reduce environmental noise.

10. When sleeping outside the usual sleep period (during the day) or location, prepare as if it were the normal sleep period and wear normal sleep clothes, darken the room, keep noise to minimum, or use white noise generator (e.g., a fan).

11. Take advantage of posture effects (most effective position for sleep is the supine rather than the reclined position).

12. Develop an exercise routine, do mild exercise for 1 hour or engage in aerobic exercise as exercise enhances sleep quality, but do not exercise within 3 to 4 hours before bed time. Exercise has a temporary alerting effect.

13. Do not use caffeine within 4 hours of bed time.

14. Do not use alcohol as a sleep aid. Although alcohol helps one to fall asleep, it disrupts the sleep architecture (the 4 stages of NREM sleep and REM sleep).

15. Alcohol, while initially relaxing, significantly worsens the duration and quality of sleep. Alcohol reduces the durations of Stages 3 and 4 NREM sleep and REM sleep, and thereby affects dream sleep, a key component in recharging the brain (Smith & Smith, 2003).

16. Avoid large meals before going to bed (2 hours before sleep for digestion).

17. Do not smoke immediately before bed (nicotine is a stimulant and may cause respiratory problems).

18. If unable to fall asleep after 30 minutes, do not remain in bed awake. Instead, get up to avoid associations of waking and anxiety with sleeping in the bed. Stay up for several minutes and try again, repeat if necessary until fatigue takes over.

19. After 24 to 48 hours of sleep deprivation, do not sleep overly long during the recovery period (no more than 10 hours). Sleeping too long may interfere with the normal sleep/wake schedule and will cause significant sleep inertia and lethargy during the day. The normal sleep period for an individual is usually sufficient to recover from 24 hours of sleep deprivation. The limitations associated with this countermeasure for fatigue tend to be beyond the control of the individual such as duty start times, rotation of work schedule, jet lag, and sleep environments.

5.1.3 Implement strategic naps or short sleeps

Napping involves sleeping for a short period of time during work or other wakefulness periods. Strategic naps or short sleep are the most under-utilised countermeasures. They can acutely improve alertness as they treat the problem not the symptoms, therefore reducing fatigue directly. A nap reduces the duration of continuous wakefulness before and during a work period and can be particularly beneficial before a period of night work. It has been shown that naps maintain performance compared to baseline conditions or improve performance compared to conditions of prolonged wakefulness without naps (Rosekind et al., 1994b). Therefore, a nap can reduce the length of continuous wakefulness before a work period and can be beneficial before a period of night work when the circadian cycle is at its low point.

If the pace of operations and the available staffing permits, naps can be used to sustain performance during continuous operations. When possible, aircrews should be allowed to nap in-flight during long missions. For example, controlled rest on the flight deck has been shown to be an effective in-flight countermeasure, but it is not the panacea for all of the sleep loss and circadian disruption engendered by long-haul flight operations (Rosekind et al., 1991). Strategic naps will not totally alleviate the effects of sleep deprivation. Waking out of deep sleep, particularly awakening from sleep that follows a long period of sleep deprivation, leads to feelings of grogginess and disorientation referred to as sleep inertia that can last 20 minutes or more. Sleep inertia is a function of sleep depth. The longer that one stays awake, the shorter is the time to the onset of slow wave sleep (SWS) and the shorter is the duration (in minutes) of SWS. In some individuals, extensive sleep inertia can last up to an hour when one is awakened from SWS, which occurs most often in the middle of each 90 - 100 minute sleep cycle. Sleep inertia is shorter after REM sleeps, where it lasts for one or two minutes. Non-habitual "nappers" experience sleep inertia more frequently, although "practise napping" may reduce this problem. Approximately 20 minutes should be allowed after a nap before engaging in mentally or physically demanding activity. Whether or not napping is rejuvenating and benefits performance depends on a number of factors including the timing of naps, nap duration, quality of prior sleep, napping experience and sleep inertia.

Sleep inertia relates to the difficulty in awakening and is associated with great sluggishness and impaired mental functioning. It can last for 20 minutes or more after SWS. In some individuals, extensive sleep inertia can last up to an hour when one is awakened from SWS, which occurs most often in the middle of each 90 - 100 minute sleep cycle. Non-habitual nappers experience sleep inertia more frequently, although practise napping may reduce this problem. Sleep inertia is shorter after REM sleep, where it lasts for one or two minutes. Awakening from sleep that follows a long period of sleep deprivation leads to high levels of sleep inertia. An even longer sleep deprivation period will lead to even longer sleep inertia. Sleep inertia is a function of sleep depth. The longer the time that one stays awake, the shorter is the latency to SWS, and the shorter is the duration (in minutes) of SWS per 2 hour nap across 54 hours awake time (Rosekind et al., 1995).

In general, brief naps of 10 to 20 minutes taken in the mid-afternoon near the circadian dip (1400 - 1700 hours) are resistant to sleep inertia and are beneficial at improving alertness and cognitive performance following either sufficient or restricted nocturnal sleep (Hayashi et al., 1999a; Takahashi, 2003). Individuals who take shorter naps in the early afternoon (at around 1200 hours) show reduced cognitive performance (Hayashi et al, 1999b). Naps of greater than 30 minutes are susceptible to sleep inertia and negative moods due to awakening from NREM deep sleep; while naps taken during the "forbidden zone" between 1900 and 2100 hours (Lavie & Weler, 1989) are also highly susceptible to sleep inertia. However, the overall restorative benefits of longer naps, particularly those lasting at least one NREM:REM cycle of 90 minutes sleep and following nocturnal sleep restrictions may outweigh any negative effects of sleep inertia, particularly if time is available for sleep inertia to dissipate. Shorter naps should be between 10 to 20 minutes; longer naps should be at least 90 minutes long to avoid awakening from NREM deep sleep (Taub, 1979).

5.1.3.1 Recommendations on napping and short sleep

1. Napping should not be used as a substitute for obtaining enough sleep during the regular sleep period.

2. Napping should take place before significant sleep loss has occurred.

3. Strategic naps should be designed and implemented so that they will provide adequate rest while dramatically shortening the period of sleep inertia.

4. Current literature suggests that naps of less than 40 minutes, or 3 to 4 hours of short sleep are much more restorative than any other length of time. The period suggested is from the time one attempts to sleep to the time of awakening. The period of napping is designed to be short enough so that the individual will not enter SWS (since the first SWS epoch occurs within about 60 minutes) but will still receive a brief restorative nap.

5. The short nap used as a "power nap" usually will provide 2 to 4 hours of useful wakefulness (i.e., useful physical and mental activity). Short power naps may be used for about 2 to 3 days without significant impact on mission success. However, after a few days, cumulative sleep debt would be overwhelming and debilitating.

6. For continuous operations during which aircrew must return to work immediately upon wakening, naps in the circadian trough (which occurs at about 0400 hours when body temperature and alertness are at their lowest and endogenous release of melatonin is at its highest – see *Figure 8*) should be avoided because sleep inertia will be high.

7. Naps do not totally eliminate the normal circadian dip experienced in the early morning around 0500 hours, but it is believed that the degradation in both cognitive performance and alertness is reduced.

8. It is easier to nap when core temperature is at its trough, around 0300 hours (0100 - 0600 hours) and 1300 hours; and more difficult when core temperature is at its peak, around 1500 hours (1400 - 1600 hours; Caldwell et al., 2005).

9. Using sleep medications for naps if they occur at a non-conducive time, the medication chosen should avoid a post-nap drug hangover.

10. Medications with short half-lives are best for initiating and maintaining naps (e.g., Zolpidem (Ambien®) has a half-life of 2.5 hours with grounding time (time between

administration of medication and flying) of 8 hours; Zaleplon (Sonata®) has a half-life of 1 hour and grounding time of 12 hours).

11. Longer rest periods (10 - 12 hours) should be implemented for an individual to recover from an extended period of napping such as during a continuous operation.

12. Short sleep, of 3 to 4 hours, is best when more time is available but not enough for a full sleep. The short sleep can maintain useful waking performance levels for 4 - 10 hours or longer. Anecdotal evidence (from the United States Air Force [USAF]) suggests that 3 - 4 hour short sleeps per day can maintain personnel in operational condition for 4 - 5 days before sleep deprivation becomes overwhelming.

13. Short sleeps are the most efficient during the circadian performance nadir.

5.1.4 Anchor sleep

Some work schedules may not allow an operator to obtain a full 8 hours of sleep at the same time period every day. In order to effectively cope with such schedules, *anchor sleep* -- defined as a regular sleep period of at least 4 hours duration and obtained at the same time each day -- can be used as a supplement. An additional sleep should be taken when its schedule allows it. Anchor sleep helps to stabilize the circadian rhythm to a 24-hour period. If possible, the anchor sleep period should be timed so that the individual's circadian rhythm's high and low points correspond to the work and sleep periods. When scheduling anchor sleep, attention should be paid to caffeine consumption, and the supplemental sleep should be taken farther away from the anchor sleep period. Meals should be taken at the times that one normally eats. Similar to a napping strategy, anchor sleep should not be used as a substitute for obtaining sufficient sleep (i.e., 7 - 8 hours) during any 24-hour period.

5.1.5 Judicious use of caffeine

Caffeine is readily available, socially acceptable, and relatively safe. That said, the performance effects of caffeine are variable. In general, caffeine affects the nervous system within 15 to 20 minutes of ingestion and its effects last 4 - 6 hours after ingestion. It has been reported that large doses of caffeine (3 - 6 cups of coffee) can temporarily reverse the performance decrements that follow 48 hours of continuous wakefulness. Doses of 100 - 600 mg are effective in people who do not normally use caffeine. However, caffeine should be used judiciously immediately before needed. For example, as stated earlier, 3 - 7 days prior to deployment, it may be useful to decrease caffeine consumption to no more than 2 cups of coffee per day or 3 carbonated-caffeinated beverages per day. This strategy may enhance the effects of caffeine during actual deployment when alerting effects are needed.

It has been suggested that caffeine could be used (McCallum et al., 2005):

- In the middle of a night shift (especially in the first and second day of the work week when circadian disruption is most pronounced and alertness is compromised)
- In mid afternoon when the post-lunch alertness dip is greatest
- Prior to an early morning commute following a night shift but not within 4 hours of a scheduled sleep period

One of the limitations in using caffeine is the gradual build up of tolerance to repeated consumption of high levels (e.g., more than 5 cups) of coffee per day. Heavy caffeine users (4 - 5 cups of coffee or 250 - 375 ml servings of caffeinated drinks) develop tolerance quickly; much larger doses are needed to maintain consistent alerting effects. It is advisable that one should not consume more than 2 cups of coffee during the work period. *Table 2* lists the amount of caffeine in coffee and other commonly used ingestion products. Sudden caffeine withdrawal can produce adverse effects on performance and mood, and often results in headache. Ingesting large amounts of caffeine regularly can render it ineffective in maintaining alertness. Frequently reported side effects include rapid heart rate, anxiety, tremor, frequent urination, and upset stomach. These same symptoms can be precipitated by withdrawal of caffeine after prolonged use.

Table 2: Amount of caffeine in common food products and medication (Caffeine Fact Sheet, NSW Health Centre for Drug and Alcohol, Website 22 Feb 2002).

What?	How much caffeine?	Comments
Instant coffee	60 - 100 mg/cup	Caffeine content depends on how much you put in your cup.
Fresh coffee	80 - 350 mg/cup (i.e., 250 ml)	Caffeine content depends on: - The type of beans (“Robusta” contains more caffeine than “Arabica”) - The way the coffee is made. - How strong is the brew.
Decaffeinated coffee	2 - 4 mg/cup	The amount of caffeine is usually marked on the package.
Tea	8 - 90 mg/cup	Caffeine depends on how strong is the brew.
Cola drinks	35 mg/250 ml	Often contains much sugar.
Cocoa and chocolates	10 - 70 mg/cup	Caffeine content depends on how strong the brew is, and other chemical content in the product.
Chocolate bars	20 - 60 mg/200g	Contains much sugar
Some prescription and over-the-counter medications	20 - 100 mg/dose	Medicine for cough and headache and slimming products contain caffeine.

5.1.6 Guidelines for duty/rest scheduling

A comprehensive duty/rest program should involve all personnel, equipment and policies that are related to mission accomplishment and safety. It should be emphasized that there is no “one-size-fits-all” schedule, and that no scheduling approach can eliminate all shift work problems. The prime factors in determining adequate rest are: the available resources, the desired schedule, total duty period, amount of sleep before the day’s activity commences, circadian rhythm effects, recent work/rest/sleep history (number of hours flown during the current month, number and type of additional duties, mission complexity, types of aircraft flown), morale, and planned free time.

Other considerations could include environmental conditions (e.g., extremes of temperature, noise and vibration, physically restrictive personal equipment, and adequacy of crew rest facilities).

As mentioned earlier under the topic of sleep hygiene, adequate crew rest is normally 7 - 8 hours of uninterrupted sleep following good sleep habits. In order to ensure that an adequate sleep period is provided for the individual, it is important to distinguish between the officially designated crew rest times and the actual amount of sleep the crew gets.

A flight duty period starts when an aircrew reports for a mission, briefing, or other official duty and ends when the engines are shut down at the end of a mission, legs of a mission, or a series of missions. Deadhead time (when a crewmember who is assigned to fly as a passenger on a specific flight, not assuming any flight duty, but travels to the next assignment) should be calculated as flight duty time. If an aircrew member will perform in-flight or crew-specialty related duties (e.g., aircraft off-loading or performance data calculation in conjunction with deadheading), proper crew rest needs to be observed.

Crew rest period can be defined as the non-duty period before the flight duty period begins; this is intended to allow the aircrew member the opportunity for adequate rest before performing in-flight duties. This period usually includes the time for meals, transportation, and rest (opportunity to sleep). For example, the USAF requires at least 8 hours of continuous uninterrupted rest during the 12 hours immediately prior to the beginning of the flight duty period. If an aircrew member remains on duty after flying to perform official duties, the crew rest period begins after termination of these duties. If crew rest is interrupted so that an individual cannot obtain 8 hours of uninterrupted rest, the individual was afforded 8 more hours of uninterrupted rest, plus reasonable time to dress, eat and travel, etc. (USAF, 1998). If crew rest is violated for an individual, it is that individual's responsibility to inform the supervisor that he/she should be removed from the flight schedule if required.

Current duty/rest schedules for different CF operations are stated in 1 Canadian Air Division Orders, Volume 2, 2-003, General Flight Rules, Section 4 – Crew flying time/duty/rest/non-working days/special leave (relocation).

5.1.7 Guidelines on Shift Lag Management - when the body clock always lags behind the sudden change in work/rest schedule.

Rotation from daytime duty hours to afternoon or nighttime always results in some degree of sleep loss and fatigue during the initial days of transition, but it does not require rapid adjustment of the body clock. Night shift ending around sunrise poses the greatest challenge to the body clock and is associated with more severe circadian disruption. This is due to the difficulties in controlling light exposure and the tendency to maintain a day schedule during off-days. It takes about two weeks of continuous night work to adjust the body clock. In general, a single period of night work is more easily tolerated than three or four consecutive nights. Returning to daytime duty hours after several days or weeks of nighttime or early morning duty hours results in significant circadian disruption. At least 3 days to a week is required to resynchronize from nighttime to daytime duty. Therefore, some controls should be implemented from the beginning of the work schedule change. For example, one can control the length of the duty period, implement rest breaks, and employ optimal shift work scheduling.

5.1.7.1 Recommendations for night operations/shift lag hazards

1. Personnel permanently assigned to night shift should avoid exposure to daylight in the morning in order to minimize the natural synchronization of physiological and cognitive resources with daylight hours.

2. Wearing dark sunglasses helps reduce unavoidable early morning exposure to sunlight. Upon awakening, engage in outdoor activities as much as possible in the afternoon. Consuming only 100 mg of caffeine (1 cup of coffee) prior to reporting for duty helps maintain alertness.

3. If the shift change is only for 1 to 3 days, changing the sleep cycle may unnecessarily shift the body clock. Sleeping 8 hours after a midnight shift during the day can alter the normal circadian pattern which is advantageous to maintain. Therefore, a short sleep immediately after the midnight shift and shortly before the next midnight shift should make it easier for most individuals to stay on a normal body cycle.

4. Use sufficiently bright lights in the work environment during a night shift in order to resynchronize the circadian timing system to the nocturnal schedule.

5. Maintain near to complete darkness in daytime sleeping quarters.

6. Reduce daytime environmental noise to a minimum.

7. Follow a consistent sleep and meal timing schedule from day-to-day.

8. Eat light meals prior to retiring and schedule the heaviest meal between 1300 to 2000 hours.

9. Maintain the same schedule of sleep, wake-up, and meal times during days off.

10. Avoid frequent shift rotations and allow shifts to continue for at least 2 to 3 weeks.

11. Fatigue management software may be used to predict fatigue, and to assist in operational planning and scheduling.

5.1.7.2 General recommendation on shift management – to keep worker fatigue to a minimum during continuous operations

1. Maintain a maximal shift length of 8 hours not including lunch/meal breaks with the exception of 12 hours maximum for surge or contingency operations.

2. All workers must receive equitable shift and weekend work assignments.

3. Shift system - set the relative numbers of work and free periods. For example, a 40-hour work week can be arranged as 5 Work days (W)/2 Free days (F), or 10W/4F, or 15W/6F or 5 night Work/2 night Free.

4. Shift lengths of 4, 6, 8 or 12 hours duration are useful.

5. Shift rotation should be forward on the clock: from day (D) to swing (S) to night (N) as follows: DSNDSNDSN. (Backward rotation from night to swing to day allows inadequate rest time (8 hours) or very long periods (32 hours) between shifts at the point of rotation.)

6. Night shift should always occur before free days (based on the idea that recovery from night work should occur during free days rather than during work days.

5.1.7.3 Shift rotation plan

Whenever possible and given the consideration of operational requirements, the shift rotation plan should allow 2 or more consecutive free days. The number of work days should be restricted to 6 or fewer consecutive days. The plan should allow as many free weekends per month as possible. It should be noted that a shift rotation plan is a controversial topic. It is biased towards slow or no rotation as it is believed that it will allow workers time to acclimatize to a given shift. However, current scientific evidence does not support this claim. No acclimatization is evident in one week and some acclimatization may take place in a month. A shift change placed after dawn would maximize the quality of rest for the day shift. Supervision should be implemented to keep the night workers alert and effective during the hours before dawn.

5.1.8 Guidelines for trans-meridian travel: how to manage jet lag

As described in the section on circadian rhythm, when flying to a new time zone, the circadian clock cannot adjust immediately. Doing so necessitates a certain amount of time, depending on the severity of the change. Jet lag can be defined as the condition where the circadian clock is out of step with the environment. Careful considerations must be given to the direction of travel, the number of time zones crossed, the time of duty, the duration of travel, and individual differences in adaptation. After a transmeridian flight, not only is the circadian clock out of step with the local time zone, but different physiological functions (hormone secretions, basal temperature and blood pressure) are also out of step with one another (Rosekind et al., 1999). The typical guidance given is to provide a conservative 24-hour recovery period for each time zone travelled. For example, following eastward or westward travel during which 4 or more time zones are crossed, re-adaptation can take from 4 days to several weeks. The amount of time required for re-adaptation depends on whether or not effective coping strategies are implemented soon after arrival to the new time zone. Inconsistent sleep/wake and daylight exposure schedules delay adaptation of the body clock to the destination time zone.

Other than individual differences, the ability to adapt appears to decrease with increasing age. Westward travel appears to be more natural to the circadian clock and is therefore easier than eastward travel. A general rule is that the body cycles change at a rate of 40 minutes/day when travelling east and 60 minutes/day when travelling west. Therefore, westward travel requires less time to acclimate. Fatigue manifests itself in “early night” for westward travelers and in reduction in total sleep duration for eastward travelers.

5.1.8.1 Recommendations for jet lag management when travelling to a new time zone for more than a week (abbreviated from US AMC Instruction 90-801, Air Mobility Command, 27 December 2005).

1. Pre-adaptation (deploying personnel begin shifting their sleep/wake cycle several days before transition) if resources are available. It serves to ease the sudden transition to a new sleep/wake cycle. However, it requires the coordination of other units and families.

2. The number of days devoted to pre-adaptation and the maximal number of hours that can be shifted daily will depend on many factors including the number of time zones to be crossed and the amount of advance notice received. For planning purposes, the magnitude of the phase shift should be 1 hour per day.

3. Carefully scheduled exposure to sunlight or proper artificial light can speed adaptation to a new work schedule or time zone.

4. Exposure to luminance levels of above 2500 lux (dawn brightness) for at least 1 hour is necessary to affect the body's timing mechanism.

5. For individuals who are accustomed to sleeping during the night, working during the day, and retiring at or about 2200 hours, day light or sufficiently bright light exposure between 0300 and 0700 hours origination time will consistently advance sleep onset approximately 1 to 3 hours earlier per day.

6. Several days (3 - 7 day) prior to deployment, it may be useful to decrease caffeine consumption to no more than 2 cups of coffee per day or 3 carbonated caffeinated beverages. This will enhance the effects of caffeine during actual deployment.

5.1.8.2 Adaptation to eastward deployment for daytime duty hours

1. It requires sleep to begin at an earlier time of day relative to the pre-deployment time zone (advancing the body clock). Individuals might experience difficulty falling asleep during travel and upon arrival.

2. Beginning on the day of travel, daylight exposure should be scheduled to begin between 0300 and 0700 hours originating time. This is the period of time in which daylight exposure helps advance sleep-onset time. Exposure to daylight between 2100 and 0200 hours originating time will induce delays in bedtimes and may delay adaptation to the new work/rest schedule.

3. The sleep/wake cycle could be adapted to the new time zone several days prior to departure by using bright artificial light (if it is practical) during the early morning hours (0400 – 0700 hours). For example, exposure to bright light at 2500 lux for 2 hours (0400 – 0600 hours) beginning 3 days prior to departure is recommended.

5.1.8.3 Adaptation to eastward deployment for nighttime duty hours

1. The body clock might not require a severe shift since actual sleep and wake-up times tends to remain in the originating time zone. This change may actually require no more than a 4- to 5-hour change in sleep-onset time.

2. Napping for half an hour prior to reporting for the nighttime duty hour, avoiding sleep inertia and the use caffeinated beverages prior to reporting to duty may help enhance alertness.

5.1.8.4 Adaptation to westward deployment for daytime duty hours

1. This requires delaying bedtime which is generally easier than advancing the sleep cycle.

2. One should maintain regular wake-up times in agreement with the duty schedule, and should seek day light exposure particularly during the first 5 days of adaptation.

3. Pre-adaptation requires airmen to wake up later (relative to originating time) as many hours as time zones crossed.

5.1.8.5 Adaptation to westward deployment for nighttime duty hours

1. It requires the resetting of sleep to begin at an earlier time of day, relative to the pre-deployment time zone. Therefore, difficulty in falling asleep during travel and upon arrival may be experienced. In deployments requiring crossing more than 4 time zones, sleep may take place at times too early for the body clock to readjust quickly. Jet lag may be experienced throughout the first 4 - 5 days.

2. Artificial bright light can be used to influence the changes in sleep prior to or during shift changes or deployments. Providing a brightly lit work area for night-shift workers may be of benefit unless a dark or semi-dark environment is required.

3. Wearing dark sunglasses may minimize unwanted exposure to day light.

4. During travel, aircrew should be shifting to the destination time zone. Sleep should occur based on destination time and should be avoided at other times. Upon arrival, personnel should maintain regular wake-up times matching the duty schedule. Daylight exposure should be optimised to maintain the body clock.

In recent years, DRDC Toronto has performed 7 laboratory studies in an attempt to manipulate circadian rhythm; the readers are referred to the Technical Report on Management of Circadian Desynchrony (Jetlag and Shiftlag) in CF Air Operations (Paul et al., 2010).

5.2 Generally approved but restricted pharmacological interventions for fatigue management

5.2.1 Guidelines for using sedatives

It is common knowledge that under certain circumstances, aircrew and pilots may have an opportunity to sleep but may be unable to do so because of various factors such as the time-of-day, anxiety, noise, extreme temperatures, etc. The use of sedative-hypnotic drugs (sleep aids) under medical supervision may be an option provided that it is approved by the Command and CF Health Services. In the operational environment, prescription sedatives should be used only after non-pharmacological methods have been exhausted and should be used only under the guidance of a flight surgeon. Caldwell et al. (2003) suggested that medications that improve daytime sleep can enhance nighttime performance, but side effects such as short term memory loss and amnesia can occur after the use of any sleep aid. Sedatives should be selected based on their pharmacological properties, including speed of onset and duration of action. Use of pharmacological agents may be associated with adverse reactions that may be individual in nature, and therefore require ground trial prior to operational use.

It is possible to develop a dependence on sedatives if used for a long period of time and there is often a "rebound insomnia" in which sleep is disrupted for 1 or 2 nights after discontinuing the drug even if it was used for a short period of time. This may include difficulty falling asleep and frequent awakening during the night. This effect should be taken into account when prescribing these medications. It is important to note that, although sedatives can be used to induce sleep during jet lag, they do not re-set the circadian rhythm. Sedatives can help with "out of phase" sleep after a shift rotation. If they are used for circadian readjustment, their use should be limited to 3 - 4 days.

5.2.2 Current CF policy on pharmacological intervention

CF Flight Surgeon Guideline on Medication and Aircrew (FSG 1900-01) stated the following: Under certain specific operational conditions; and with the approval from the 1 Canadian Air Division Surgeon or the Canadian Forces Environmental Medicine Establishment (CFEME)/Medical Consultation Services, short-acting sedatives may be used to facilitate sleep given certain circumstances and caveats. Specifically, the medication should be trialed on the ground for at least one sleep period before being used operationally. The use of a hypnotic may then be considered for following circumstances:

- During stop-over in long-haul transport operations (i.e., specific to the transport community);
- Facilitating off-nominal sleep for limited periods (e.g., change in shift work schedule from days to nights or vice versa in any community);
- Facilitating circadian phase shifting (i.e., reducing the effects of jet lag in any community);
- Short-acting sedatives are not intended for and will not be used for facilitating day/night operations for more than five consecutive days; and

- To facilitate sleep when there is a minimum of eight (8) hours before drug ingestion and report-for-duty to the next duty period, the use of Zopiclone (Imovane®) (5 or 7.5 mg) is recommended. Temazepam (Restoril®) (15 mg) is an acceptable alternative. Note that in the CF Formulary, Zopiclone requires Special Authorization, and Temazepam requires an exception.

Other information on available sleep aids is attached as **Annex C**.

5.2.3 Practical recommendations

1. In the operational environment, sleep aids (in the lowest clinically indicated dose) should be used only as a last choice and should be used under the guidance of the physician and only for as long as necessary to limit sleeplessness.

2. Factors such as availability, duration of action, incidences of side-effects (e.g., amnesia and sleep inertia) should be considered carefully.

3. Side effects (e.g., short-term memory loss, amnesia) can occur after the use of any sleep aid and can be dangerous in the military operational environment.

4. If the drug is long-acting or if the individual has high sensitivity, there may be a "hangover" effect the next day such that the individual may feel sluggish.

5. Sleep aids that can improve daytime sleep (e.g., Temazepam) can enhance nighttime performance (Caldwell et al., 2003).

6. Sleep aids can improve ill-timed naps – naps that occur at a non-sleep-conducive time (Caldwell & Caldwell, 1998; Caldwell & Caldwell, 2005). For example, medications with short half-life are best for initiating and maintaining naps (e.g., Zolpidem and Zaleplon, both of which should minimize post-nap drug hangover).

7. It is important not to accompany sleep aids with alcohol as the side effects will be amplified.

8. Certain sleep aids such as Zaleplon (Sonata®) have a relatively high potential to be abused for the following reason: the fast-acting nature and short half-life of the chemical mean that high dosages act much more quickly and last for short periods of time (usually from 45 to 60 minutes). Inhalation of the drug causes effects to happen even more quickly, and last for even shorter periods of time.

9. All sleep aids to be considered for use in operations should be pre-tested on the potential recipient under controlled conditions and under the guidance of the Flight Surgeons.

10. There are individual differences in the duration of sleep inertia after taking these drugs. Aircrews who are asked to perform their duties within the duration of time the drug is stated to have therapeutic effect (e.g., an adult dose may have a therapeutic effect for 2 hours, or a 1 hour half-life) should be monitored for sleep inertia effects.

11. It is unwise to become dependent on sleep medications, sleep aids may not be necessary except in extreme situations.

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6 Operationally Restricted Fatigue Countermeasures

6.1.1 Guidelines for pharmacological stimulants

No stimulants are authorized for use in CF aircrew at present. In general, this class of drug is not compatible with flying duties.

However, in some of the United States (US) commands, pharmacological stimulants may be used when all other efforts at fatigue management have proven insufficient to maintain performance at the required level and when authorized by the chain-of-command. The use of stimulants requires close coordination between the commanding officer and flight surgeon. It should be emphasized that controlled stimulants have high addiction and abuse potential. All medications used in operational settings should be ground-tested on potential recipients under controlled conditions to decrease the possibility that adverse reactions will occur during flight.

When stimulants are considered for use, a risk analysis is essential. The factors contributing to that analysis include the length of duty periods, time of day, mission type, and aircraft type (which dictates what other fatigue countermeasures are available in flight). The commanding officer must understand that a decision to use prescription stimulants may represent a failure of regular fatigue management procedures. When a decision to use stimulants is made, a review of current fatigue management strategies should be undertaken to assess how they may be improved and when they should be discontinued. In addition, the use of stimulants can produce unwanted side-effects such as a significant lack of sleep. Following use, a compensatory rest period is required. The length of the rest period depends on the specific medication prescribed.

6.1.2 General guidelines on controlled stimulants:

1. Stimulants should be administered at least 1 hour before critical performance periods because it takes time to obtain the peak drug effects.

2. Stimulants should be administered to someone who has gone 24 hours or more without sleep.

3. Lower doses will be required during daytime than during night time work periods.

4. The last dose should be given far enough in advance of the scheduled sleep period.

5. Avoid using sleep aids to induce sleep in soldiers who have been kept awake with stimulants (and vice versa).

6. Stimulants represent only a temporary solution.

7. Tolerance to stimulants develops quickly.

8. All drugs to be used in operational settings should be pre-tested on potential recipients under controlled conditions to ensure that adverse reactions do not occur.

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7 Interventions That Require Further Research

7.1 Nutrition

An attempt to extend an individual's endurance or promote sleep by altering the content of meals is complex and impractical in the operational setting. It is better to focus on regularly consuming a nutritious and balanced diet at the appropriate times of day (Landstrom et al., 2000; Wells et al., 1998). Meal services should be available to accommodate the needs of personnel working evening and night shifts. There are many myths and misconceptions about nutrition and alertness/drowsiness based on unsubstantiated claims by overzealous dietary supplement manufacturers. For example, it is believed that carbohydrates cause drowsiness and protein foods maintain alertness, or that milk and turkey (which contain tryptophan) cause drowsiness. However, current evidence suggests that specific food content has little, if any, impact on the level of alertness or feelings of sleepiness. It is understood that large meals regardless of their composition induce drowsiness. Some dietary behaviour can be a determining factor in sleep quality and duration. For example, eating heavy or spicy foods just prior to bedtime can interfere with sleep by causing heartburn. Consuming alcohol just prior to bedtime can induce sleep initially, but tends to lead to fragmented sleep. Finally, consuming caffeine within 4 to 6 hours before bedtime can delay the onset of sleep as well as disrupt sleep. There is no empirical scientific evidence suggesting that special diets or dietary supplements improve performance and prevent fatigue, and some of these products can be potentially harmful.

7.1.1 Practical recommendations:

1. Keep properly nourished with a balanced diet.

2. Do not skip meals; eat meals at times that correspond to normal meal times. This will help maintain a regular sleep/wake cycle as meal time is also a time cue that influences circadian rhythm.

3. Do not consume large meals prior to sleep. This can result in gastrointestinal discomfort and disrupt the subsequent sleep period.

4. Keep adequately hydrated.

5. Caffeine in moderate doses (100 - 200 mg every 3 - 4 hours) can restore vigilance and alertness, but it cannot substitute for sleep. At high doses, it may impair fine motor coordination and control. Caffeine is not useful for individuals already consuming 300 mg or more of caffeine a day.

6. Do not consume dietary supplements without checking with flight surgeons.

7.2 Over-the-counter (OTC) preparations

The primary advantage of over-the-counter (OTC) preparations is that they are readily available without a prescription. Due to their unregulated status, they have not been well studied. Herbal remedies such as Valerian root, chamomile, kava, and lavender are promoted as sleep aids.

However, there is no clear evidence of their effectiveness. The principal ingredient in most of the OTC sleep aids is diphenhydramine (Benadryl®), which is an antihistamine and appears to have a sedating effect. OTC stimulants (including energy drinks, caffeine tablets and gum, and guarana) are used in greater proportions than prescription drugs for maintaining wakefulness. Although caffeine gum has been tested extensively (Kamimori et al., 2005; Penetar et al., 1993; Smith, 2009), limited research has focused on other non-prescription drugs.

Both stimulants and sedatives may be characterized by poor quality control during their manufacturing, leading to unpredictable and potentially harmful effects. There are documented performance degradations and hangover effects. We do not recommend their use.

7.2.1 Chronobiotics – specifically melatonin

Chronobiotics are drugs, hormones, and light treatments that are potentially capable of accelerating the adaptation of the circadian clock to a new time zone or a new work/rest schedule. It is beyond the scope of this publication to discuss all types of chronobiotics. We will restrict the discussion to melatonin as it receives the most attention and is readily available. It is not possible to address all published articles regarding its usefulness or lack thereof here. A noteworthy study (Comperatore et al., 1996), simulating military rapid deployment and night operations, concluded that melatonin can be a useful treatment for the prevention of sleep disruption and cognitive degradation. However, the authors also stated that: “It is difficult to unequivocally ascertain whether the changes that [were] reported are mediated via melatonin’s hypnotic or chronobiotic properties and that to test melatonin’s chronbiotic efficacy during real world military missions may require a greater challenge to the biological clock”. A study by Paul et al. (2004) demonstrated that melatonin and zopicolone (a hypnotic drug) are equipotent facilitators of early sleep during transmeridian air transport operations; however, there were no measurements of operational performance. Further research is needed to test melatonin’s effectiveness in real world military missions.

Two meta-analysis studies regarding melatonin are briefly described below to facilitate the understanding of the effects of melatonin and to provide a balanced view. Meta-analyses are those that identify a common-effect size that addresses a set of related research hypothesis (in this case, whether or not melatonin is effective in preventing sleep disorders accompanying sleep restrictions such as jet lag and shift lag). This is followed by some general information on melatonin and its practical implications.

Meta-analysis studies - Buscemi et al. (2006) using close to 1200 data sets concluded that: “There is no evidence that melatonin is effective in treating secondary sleep disorders or sleep disorders accompanying sleep restriction. The described sleep restriction includes inadequate sleep as a result of imposed or self-imposed lifestyles and work schedule such as air travel and shift work. Specifically, melatonin does not have a significant effect on sleep onset latency or on sleep efficiency.” On the other hand, Herxheimer & Petrie (2002), who examined the effects of melatonin on both the daytime fatigue and the sleep disturbance aspect of jet lag, suggested that melatonin is effective in preventing or reducing jet lag. Although Buscemi et al. did not determine the effect of melatonin on measures of daytime fatigue, their systematic analysis also did not provide evidence that melatonin is effective in alleviating sleep disturbance in jet lag. It should also be noted that for the outcome measures (as part of the selection criteria), Herxheimer & Petrie relied largely on subjective rating of jet lag or related components. Given the contradictory conclusions reached by earlier met-analyses (Buscemi et al., 2006; Herxheimer &

Petrie, 2002), further analysis is needed to clarify conditions under which melatonin may be effective in preventing or reducing jet lag.

The information provided below is given strictly for a basic understanding and a consideration for its practical use. As eluded in Section **4**, melatonin secreted by the pineal gland at night is associated with biological timing. Bright light suppresses melatonin secretion, and darkness causes the pineal gland to release melatonin causing sleepiness. When more than 3 time zones are crossed, the circadian cycle continues with the body clock which is the primary regulator of melatonin, not the local time zone (Northrup, 1997). Over 30 years ago, it was reported that ingestion of melatonin supplements (from synthetic or animal sources) has acute sleep-inducing effects (Lerner & Nordlund, 1978).

Timing of administration - There are a number of practical considerations that influence the potential usefulness of chronobiotics in flight crew. For example, the timing in the cycle at which a chronobiotic is administered is critical for its effectiveness. Care must be taken in the timing of the dose as phase advance or phase delay may result. Use of melatonin to delay the circadian rhythm is complicated by the individual's interaction with daylight, the latter of which is a more powerful adaptation mechanism. Furthermore, large individual differences in the rate and direction of adaptation complicate the timing of treatment according to individual circadian phases (Arendt, 2009). When combined with proper timing and light exposure, melatonin can help to adjust the circadian rhythm to new schedules, and reduce the effects of fatigue and jet lag. When the administration of melatonin is suitably timed, it will shift the phase of the human circadian clock. Melatonin is better at advancing (to earlier times) than delaying (to later times) the circadian rhythm (Sharkey & Eastman, 2002). It is suggested that melatonin should be taken well below the low point of an individual's circadian rhythm. For example, when travelling eastward, melatonin should be taken around 2100 hours Eastern Standard Time in order to promote sleep at a time when one would otherwise be awake. A detailed discussion on the timing of melatonin administration is described in Paul et al. (2010).

Dosages - Specifically, between 0.5 to 5 mg of melatonin can shift the circadian rhythm. Melatonin is available in two forms: fast-release (plain melatonin) and slow-release (a special preparation designed to spread melatonin absorption over many hours). It appears reasonable to suppose that fast-release melatonin helps in falling asleep, while slow-release melatonin helps in staying asleep, but current results are unclear. In a double-blind study, a 5-mg fast-release formulation significantly improved the self-rated sleep quality, shortened sleep latency, and reduced fatigue and daytime sleepiness after intercontinental flight over 6 to 8 time zones. The lower physiological dose of 0.5 mg was almost as effective as the pharmacological dose of 5.0 mg (Suhner et al., 1998). Only the hypnotic properties of melatonin - sleep quality and sleep latency - were significantly greater with the 5.0 mg dose. The fast-release melatonin formulations appear to be more effective than the slow-release formulation.

Sleep quality - It is important to recognize that melatonin does not always improve sleep duration or sleep quality (Cavallo et al., 2005). The sleep inducing effects of melatonin are temporary, so, while an individual may be able to get to sleep at an unusual time by using melatonin, he/she may not be able to stay asleep for as long as desired. At best, melatonin can shift the body clock about 1 hour per day (Caldwell & Caldwell, 2009). The effectiveness of melatonin varies greatly between individuals due to the difference in pharmacokinetics (absorption, distribution, metabolism and elimination of the drug). In some cases, melatonin could be useful for aircrew, however, it should be noted that aircrew experiences compound circadian disruptions caused by rapidly alternating time zone transitions, night flying, early departures, and irregular work schedules. Their jet lag symptoms are often masked by operational demands and personal sleep-activity strategies. Furthermore, although melatonin has been deemed safe for short term use (Buscemi et al., 2006), there are concerns about its safety and effectiveness (Valk & Simons, 2009). Amidst the controversies on the effectiveness of melatonin, one should also distinguish the use of melatonin in jet lag versus its use in shift lag. Arendt & Skene (2005) concluded that although melatonin appears to show some benefit in the reduction in subjective jet lag, the evidence for using melatonin to adapt to night-shift work is inconclusive.

Other effects - It should be recognized that melatonin affects a variety of physiological systems beyond those impacting its sleep and circadian rhythms. The reported side effects of melatonin include rapid heart rate (tachycardia), headache, drowsiness, insomnia, depression, impaired mental performance, impaired sleep, nightmares and vivid dreams, agitation, gastrointestinal disturbance, nausea, difficulty conceiving, and low sex drive. Various other side effects of melatonin have been reported, including worsened fatigue, depression, coronary artery constriction, and possible effects on fertility. No long term safety data exist, although Buscemi et al. (2006) have reported that melatonin is safe with short-term use. The pharmacology and toxicology of melatonin needs systematic study and routine pharmaceutical quality control of melatonin products must be established (Herxheimer & Petrie, 2002). There is insufficient evidence to state that it is safe for long-term use in aviators. Large scale clinical trials need to be performed to document that it poses an acceptable risk in the aviation environment, and to elucidate other interactions within the body. Therefore, the use of melatonin should be closely monitored.

Summary - Critical analysis of various purported findings plays an important role in making recommendations. As an example, the increase in sleep efficiency was reported to be statistically significant with melatonin in one analysis (Buscemi et al., 2006), but the effect was small (1.9%): an increase of less than 10 minutes if the amount of time spent asleep is 8 hours. Further field studies involving military aviators should be conducted to test melatonin's effectiveness and safety in military operations.

A recent position statement on fatigue countermeasures in aviation stated that: "There is still debate about the use of melatonin and long term safety, and for this reason we do not recommend the use of melatonin to readjust circadian rhythms or to promote sleep (Caldwell et al., 2009). Theoretically, the appropriate use of melatonin may resolve sleeping problems after a long flight (providing a sedative effect), and should speed up the resynchronization of the body clock to the new time zone, however, no quality assurance mechanism is in place for it yet. In most countries, it is not classified as a drug, and is available in health-food stores; hence, the sale of melatonin is not regulated. The percentage of active melatonin in health-food store products may vary widely. In Canada, melatonin has fallen under Health Canada's Natural Health Products Directorate since 2004, the manufacturers require citations of an approved NHP (Natural Health Product) Master file, and it must be authorized by a letter of access issued to the applicant. However, based on more recent research, melatonin is currently under review by Health Canada.

Time release melatonin products are not well studied. It would be prudent to take a conservative approach to the use of melatonin. Unfortunately, most potential users of melatonin possess little knowledge about circadian rhythms and/or endogenous melatonin secretion, and this could lead to compromised alertness and decreased performance associated with improper use (Caldwell et al., 2009). Currently, melatonin is not approved for use in aircrew of ASIC and most North Atlantic

Treaty Organization (NATO) nations. Approval will require the demonstration of reliable effects against a backdrop of minimal health concerns. This will require further systematic empirical research.

7.3 Bright light

Laboratory studies have shown that bright light facilitates circadian adaptation. Bright light (> 2500 lux) suppresses the secretion of melatonin and appears to have an independent alerting effect. Fatigue countermeasures using bright light refers to timing the exposure to outside or bright indoor light in order to shift the circadian rhythm to a new time zone or new work schedule. Bright light can be used to increase alertness at times when the circadian rhythm would otherwise be at a low point and the individual would be feeling sleepy (e.g., in the middle of a night shift).

Using light exposure for several hours over a period of several days is usually most effective in shifting the circadian rhythm. Light of 1000 lux (equivalent to a lamp directing a 60-watts light bulb at one foot from the reading material) for 2 - 3 hours is known to reset the body clock, but this has not been demonstrated to be practical or effective in some operational settings. Special equipment is required to generate this level of illumination beyond that obtained from indoor lights. Similarly, special equipment is also required when light-avoidance techniques are employed to correct circadian misalignment. For example, the use of light boxes, welder’s goggles or “blue blocker” glasses can limit the widespread acceptance of their usage.

The use of bright-light exposures is a complex undertaking. The benefits of resetting the circadian rhythm can be maintained only through rigid adherence to the procedure, and by ensuring that other time cues (e.g., day light, social activities) are minimized. For example, some work environments such as aircraft cockpits requires low light levels. In addition, use of indoor lighting levels to increase alertness may not be feasible in some work environments where night vision is required. The use of bright light as a fatigue countermeasure should be guided by a well qualified circadian physiologist. For example, in order to shift the circadian rhythm an individual needs to determine whether a rhythm advance (shifting the rhythm so that the low point in the daily cycle occurs earlier) or whether a delay (the low point occurs later) is necessitated. Advancing the rhythm will make the day seems shorter and the individual will feel sleepy earlier, while delaying the rhythm will extend the day and the individual will be able to stay up later. Of equal importance to light exposure is the control of the timing of darkness. This is especially relevant for those who require travel between work and home in the bright morning sun.

7.4 Exercise

Exercise has not been recognised as an effective countermeasure for immediate fatigue, although it can improve sleep quality by promoting regular transitions between the sleep cycles and phases of sleep. Regular exercise appears to prevent frequent episodes of sleepiness during the day. Morning or afternoon exercise is preferred. Exercise closer to bedtime can disrupt the onset of sleep. It should be emphasized that physical fitness does not mean fatigue resistance.

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8 Conclusion

This document is intended to provide basic educational information on fatigue and general recommendations on fatigue countermeasures as based on best practices derived from scientific findings. Based on critical evaluation of various strategies to counter fatigue, this report specifically addresses key issues relevant to the problem of operator fatigue and makes recommendations to improve fatigue management that will enable all personnel involved in, and those supporting, air operations to perform at their best. Our approach provides important new information on routine fatigue management including sleep hygiene, strategic naps, work/rest scheduling, circadian desynchrony and caffeine. Additional sources of information (that are not referred in the body) are included in the **Bibliography**.

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Annex A Working Memory

Three lines of evidence characterize the working memory (WM) literature. First, there are individual differences in WM capacity which in turn predict performance on demanding cognitive activities such as reasoning (Stanovich & West, 2000). Second, while some mental activities necessitate large WM resources (i.e., they are perceived as cognitively effortful), others do not (i.e., they are perceived as automatic). It is possible to determine which category a specific cognitive activity falls into by measuring the effect of adding a secondary task to the primary task. If adding a secondary task impairs performance on the primary task, the primary task is considered to require high WM resources. Otherwise, it is considered to require low WM resources. Third, WM function has been linked to a distributed neural system comprised of various frontal and parietal regions. Of particular importance is the dorsal lateral prefrontal cortex (DLPFC) which has been linked to the maintenance and manipulation of information in short-term memory. In addition to this frontal - parietal system, the anterior cingulated cortex (ACC) also plays a role due to its involvement in attention and cognitive control.

The above three lines of evidence can be extended to investigate the effect of cognitive load on cognitive performance directly. First, personnel can be tested to determine individual differences in WM capacity. This information can in turn be used for optimal matching of personnel to tasks that require varying levels of effortful processing. Second, a dual-task methodology can be used to determine the mental load necessary for carrying out various activities. This will enable one to determine which activities are more likely to result in faster rates of fatigue – and to determine rates of fatigue. Third, one can determine the effect of mental load on the neural system known to underlie WM, and to correlate brain activation in specific regions to performance impairments. Furthermore, one can study whether or not the effects of fatigue on this neural system can vary as a function of individual differences in WM capacity, as well as the nature of the mental activity under consideration (e.g., memory, visual search, etc.).

Annex B Sleep architecture disorders and hygiene

Table 3: Sleep Architecture (Summarized from Ganong 1992))

<table>
<tr><th>Sleep states</th><th colspan="2">Stages and Phases</th><th>Duration in minutes
(% of total sleep time)</th><th>EMG</th><th>EOG</th><th>EEG (Frequency)</th></tr>
<tr><td>wakefulness</td><td colspan="2"></td><td>3-5 (< 5%)</td><td>active</td><td>active</td><td>synchronized alpha waves (8-13 Hz)</td></tr>
<tr><td rowspan="4">non-rapid eye movement (NREM)</td><td colspan="2">Stage 1 (shallow sleep, sleep onset, process 'O')</td><td>2-5 (25%)</td><td>reduced muscle tone</td><td>slow, asynchronous</td><td>theta waves (4-8 Hz)</td></tr>
<tr><td colspan="2">Stage 2 (sleep deepens)</td><td>10-20 (15-20%)</td><td rowspan="3">further reduction of muscle tone</td><td rowspan="3">no activity</td><td>synchronized sleep spindles (12-14 Hz) and k-complexes</td></tr>
<tr><td>Stage 3</td><td rowspan="2">slow wave sleep (Process 'S') continues to increase</td><td>3-5 (5-8%)</td><td>synchronized high amplitude delta waves (0.5-2 Hz)</td></tr>
<tr><td>Stage 4</td><td>40 (20-25%)</td><td>> 50% delta (0.5-2 Hz) waves</td></tr>
<tr><td rowspan="2">rapid eye movement (REM)</td><td colspan="2">Phasic</td><td rowspan="2">20-25 (25%)</td><td rowspan="2">Muscle atonia - little or no muscle tone</td><td>bursts, very active and rapid</td><td rowspan="2">fast, active and desynchronized low amplitude alpha waves (8-13 Hz)</td></tr>
<tr><td colspan="2">Tonic</td><td>relatively inactive</td></tr>
<tr><td colspan="7">Sleep architecture refers to the duration of time spent in the various stages and phases of the sleep cycle, and is generally presented as a percentage of the amount of total sleep. Combined NREM and REM sleep cycles last approximately 90 minutes After REM sleep, the sleep cycle repeats itself, returning to stages 2, 3 and 4 and back to REM. Each cycle lasts about 90 minutes with 5 to 6 cycles occurring per night. EMG: Electromyography; EOG: Electro-oculography ; EEG: Electroencephalography</td></tr>
</table>

Table 4: International classification of sleep disorders, Version 2 (from ICSD, 2005)

Group	Definition	Disease
Insomnias	Repeated difficulty with sleep initiation, duration, consolidation, or quality that occurs despite adequate time and opportunity for sleep and results in some form of daytime impairment, presumably caused by the nighttime sleep difficulty	Adjustment sleep disorder (acute insomnia); psychophysiological, paradoxical or idiopathic insomnia; insomnia due to mental disorder, medical condition, drug or substance
Sleep-related breathing disorders	Characterized by abnormal respiration events during sleep	Central sleep apnea, OSA, COPD, sleep related hypoventilation/hypoxemic syndrome and others
Hypersomnias not due to a sleep-related breathing disorder	Defined as the inability to stay alert and awake during the major waking episode	NRCLP with or without features of cataplexy (sudden loss of muscle tone) and other Hypersomnias as Kleine–Levin syndrome, menstrual related or idiopathic hypersomnia
Circadian rhythm sleep disorders	Persistent or recurrent pattern of sleep disruption leading to excessive sleepiness or insomnia, that is due to a mismatching between the sleep/wake schedule required by a person's environment and their circadian sleep/wake pattern	Primary (delayed or advanced Sleep phase type, and irregular sleep–wake or free-running type) or Behaviorally Induced Circadian Rhythm Sleep Disorders (Jet Lag, shift work or delayed sleep phase type)
Parasomnias	Composed of undesirable physical or experiential events that accompany sleep, occurring during entry into sleep or during arousal from sleep	Associated with NREM (sleepwalking, sleep terrors) or REM sleep (REM sleep behavior, parasomnia overlap or nightmare disorder) and others (enuresis, catathrenia, hallucinations)
Sleep-related movement disorders	Characterized mainly by relatively simple, usually stereotyped movements, that disturb sleep, or by other muscle involvement	Restless leg syndrome (RLS) and periodic limb movements in sleep (PLMS)
Isolated symptoms, apparently normal variants, and unresolved issues	Did not have enough scientific bases for decisions regarding whether they were pathological disorders	Long or short sleeper, snoring, and sleep talking
Other sleep disorders	Unspecified disorders	Physiological, environmental or unspecified sleep disorder not due to substance or physiological condition

OSA: Obstructive Sleep Apnea; COPD: Chronic Obstructive Pulmonary Disease; NRCLP: narcolepsy: ; RLS: Restless leg syndrome; PLMS: Periodic limb movements in sleep

Table 5: Items of the Sleep Hygiene Practice Scale (from Yang et al., 2010 p.150)

Domain 1: Arousal-related Behaviors
Doing sleep-irrelevant activities in bed (e.g., watching TV, reading).
Worry about not being able to fall asleep in bed.
Unpleasant conversation prior to sleep.
Not enough time to relax prior to sleep.
Falling asleep with TV or music on.
Pondering about unresolved matters while lying in bed.
Check the time in the middle of night.
Worry about nighttime sleep during the day.
Vigorous exercise during the two hours prior to sleep.
Domain 2: Sleep Scheduling and Timing
Bedtime not consistent daily.
Get out of bed at inconsistent times.
Stay in bed after waking up in the morning.
Sleep in on weekends.
Napping or resting in bed for over one hour during the day.
Lack of exposure to outdoor light during the day.
Lack of regular exercise.
Domain 3: Eating/Drinking Behaviors
Going to bed hungry
Drinking caffeinated drinks (e.g., coffee, tea, Coca-cola™) within the four hours prior to bedtime.
Drinking alcohol within the two hours prior to bedtime.
Consuming stimulating substances (e.g., nicotine) during the two hours prior to bedtime.
Drinking a lot during the hour prior to sleep.
Eating too much food during the hour prior to sleep.
Domain 4: Sleep Environment
Sleep environment is either too noisy or too quiet.
Sleep environment is either too bright or too dark.
Sleep environment is either too humid or too dry.
Feeling too hot or too cold during sleep.
Poor ventilation of bedroom.
Uncomfortable bedding and/or pillow.
Too many sleep-unrelated items in bedroom.

Annex C Information on available sleep aids

Various types of sleep aids can be prescribed to a number of situations that might interfere with sleep such as shift changes, jet lag or stress-related short-term insomnia. The following information aims to familiarize the commanders with the different options of sedatives that are available. The barbiturates (e.g., Phenobarbital) as sedative-hypnotic drugs have been largely replaced by the much safer Benzodiazepines – Temazepam (*Restoril*®) and Triazolam (*Halcion*®). A nonbenzodiazepine agent is Zolpidem (*Ambien*®) that is recommended except for a few specialized uses. The following table provides a summary on the dosage, pros and cons of some of the available prescribed sleep aids.

Table 6: Prescribed sleep aids - dosage pros and cons (Summarized from Leader's guide to crew endurance. US Army Aeromediacl Research Laboratory1997)

Name	Usual Dose	Half-life*	Time pilot should be grounded	Pros	Cons	Comments
Temazepam (*Restoril*®)	15-30 mg 15mg before bed 15 mg/24 hr max No more than 2 days of consecutive use	10-17 hr	12 hr 6-7 hour during actual operation	Medium duration Used in military environment Few side effects	Possible mild hangover	Has been approved by US Army Aviators in the past Have been used in actual operations – Operation Desert Shield/Desert Storm
Triazolam (*Halcion*®)	0.125-0.25 mg	1.5-3 hr	12 hr 8 hour during actual operation	Medium duration Used in military environment Few side effects	Occasional amnesia with higher dose	Has been approved by US Army Aviators in the past Have been used in actual operations – Operation Desert Shield/Desert Storm
Zolpidem (*Ambien*®)	10 mg 5-10 mg before bed 10 mg per 24 hr max	1.4-4.5 hr Average 2.5 hr	6-8 hr 8 hr	Short action Free of side effects		New drug recently approved for US Army Aviators Authorized by USAF
Zaleplon (*Sonata*®)	10 mg Range from 5-20 mg	1 hour	12 hr	Short action		Authorized by USAF

* Half-life refers to half the duration of time for which the drug is effective or therapeutic.

Annex D Stimulants

Examples of controlled stimulants and their benefits and drawbacks:

Methylphenidate *(Ritalin®)*, ***Pemoline*** *(Cylert®, longer duration than Ritalin)* - The site of action is in the midbrain exerting its influence on mental activities. It can reverse the effects of fatigue on performance, and it has been shown to elicit infrequent cardiovascular effects (e.g., increase in heart rate).

Dextroamphetamine *(Dexedrine®)* - Dexedrine is capable of recovering the performance of personnel who have been fatigued or significantly sleep deprived. Preventive administration of Dexedrine can prevent many of the performance decrements attributed to sleep loss. Dosage depends on the individual, it can range from 5 - 30 mg for an optimal response. The usual dosage is 5 mg as an initial dose and it can be repeated in 15 minutes if required with 5 mg every 2 hours thereafter. The half-life of dexedrine is 10 hours. The daily dose should not exceed 30 mg. Informed consent should be obtained prior to administration. A single dosage of 60 - 300 mg is considered to be an abusive administration of the drug, and can be lethal.

Benefits of amphetamines include:

- Effective maintenance of alertness and performance of several hours at relatively low doses
- Low incidence of tremor, anxiety or gastrointestinal disturbances
- Demonstrated effectiveness in military operations

Drawbacks include:

- Highly addictive
- Dosage must be increased frequently to derive equivalent drug effects if the drug is given continuously for several days or weeks
- Increased blood pressure and heart rate
- Insomnia
- Over focusing
- Potential abuse
- Decreased appetite
- Cyclic use with sedatives

Methamphetamine *(Desoxyn®)* - It possesses greater alerting effects than dextroamphetamine with fewer cardiovascular complications and has a shorter half-life of 4 - 5 hours.

Modafinil *(Provigil®, Alertec®, Modalert®)* - Modafinil is an analeptic drug (stimulant to the central nervous system – brain and spinal cord). It has been approved by the US Food and Drug Administration to treat clinical sleep disorders and shift-work sleep disorder. It is also widely used to suppress the need for sleep and in combating general fatigue unrelated to lack of sleep, for example, as an adjunct to antidepressants. There are interests in using modafinil as an alternative to dextroamphetamine in military operations where troops will encounter sleep deprivation during lengthy missions and covert operations. It was reported that modafinil attenuated sleep deprivation effects when the combined impact of sleep loss and the circadian trough was most severe (Caldwell et al., 2000). A recent study (Rosenberg et al., 2010) demonstrated that armodafinil (a longer lasting form of modafinil) at 150 mg/day provided a significant increase in sleep latency on the Multiple Sleep Latency Test, when travelling eastward through 6 time zones. The notable side effects were headaches (27%), nausea (13%), diarrhea (5%), circadian-rhythm sleep disorder (5%) and palpitations (5%). It should be noted that this study is limited to one three-day trial, in which the global impression of clinical severity of symptoms scores only improved on the first day, and were otherwise not superior to a placebo. Moreover, the most recent analysis (McCarty, 2010) reported that melatonin may improve sleep quality and duration, but there is no definitive data to suggest improved daytime functioning. This critical review by McCarty (2010) concluded that more research is required in order to identify individuals who are most likely to benefit from armodafinil. Further investigation is needed to determine if modafinil or armodafinil improves functional measures of vigilance, alertness and its impact on nocturnal sleep quality. The risk/benefit ratio in using modafinil for the treatment of sleepiness associated with jet lag needs to be better defined.

Although extensive research has been done, the precise mechanism of modafinil's action is unclear. As eluded above, there is also a disagreement on whether or not modafinil can be considered as a cognitive enhancer. The effectiveness and safety of modafinil in long-term use has not been systematically evaluated in placebo-controlled trials. Health Canada has released a communiqué regarding the potential of modafinil in causing life-threatening skin and other serious hypersensitivities. Adverse psychiatric experience has also been reported.

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List of symbols/abbreviations/acronyms/initialisms

ACC	Anterior cingulated cortex
ADV PUB	Advisory Publication
ASIC	Air and Space Interoperability Council
ASMG	Aerospace Medical Group
ATG	Air Transport Group
BAC	Blood Alcohol Concentration
CF	Canadian Forces
CFEME	Canadian Forces Environmental Medicine Establishment
COPD	Chronic Obstructive Pulmonary Disease
DLPFC	Dorsal lateral prefrontal cortex
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
EEG	Electroencephalography
EMG	Electromyography
EOG	Electro-oculography
ICSD	International Classification of Sleep Disorders
NATO	North Atlantic Treaty Organization
NHP	Natural Health Product
NRCLP	Narcolepsy
NREM	Non-rapid eye movement
NTSB	National Transportation Safety Board
NVD	Night Vision Devices
OSA	Obstructive Sleep Apnea
OTC	Over-the-counter
PLMS	Periodic limb movements in sleep
REM	Rapid eye movement
R&D	Research & Development
RLS	Restless leg syndrome
SHPS	Sleep Hygiene Practice Scale

SWS	Slow Wave Sleep
US	United States
USAF	United States Air Force
WM	Working memory

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(U) A recent Advisory Publication (ADV PUB Number ASMG 6000, 7 Jan 2010) on Fatigue Countermeasures in Sustained and Continuous Operations recommended that all Air and Space Interoperability Council (ASIC) nations should have national policies regarding fatigue management. Currently, there is no existing doctrine and training program for fatigue risk management available in the Canadian forces (CF). The focus of this document is on the management of sleep hygiene and circadian entrainment, rather than physical, muscle fatigue, or fatigue at the cellular level. Recommendations for fatigue management are based on best practices derived from the latest scientific findings and the collation of appropriate common policies from other military forces that will enable aircrew to perform at their best. It includes a series of summaries that address what is and what is not known regarding the efficacy, implementation and limitation associated with fatigue countermeasures commonly employed. A stratified approach is adopted to ensure that promotion of sleep is the first priority under routine fatigue management, followed by generally approved pharmacological intervention. Employment of those prescription medications permitted by CF policies will be suggested only as a last resort. This document is written primarily for the Air Force; however, the general recommendations to fatigue risk management also apply to the Navy and the Army as they, too, experience sleep loss due to changing time zones and changing operational schedules. The intended key users for these recommendations include commanders, unit trainers, mission planners, medical officers, unit safety officers, and all personnel who support operations. They are well advised to familiarize themselves with the causes of fatigue and the various options in fatigue risk management. This guide is considered to be a “living” document. The material will be updated as new technological information and empirical scientific data emerge.

(U) Dans un récent document consultatif (Numéro ADV PUB ASMG 6000, 7 janvier 2010) portant sur les Mesures contre la fatigue dans les opérations soutenues et continues, on a recommandé que tous les pays membres du Air and Space Interoperability Council (ASIC) adoptent des politiques concernant la gestion de la fatigue. Actuellement, il n’existe pas de doctrine ni de programme de formation pour la gestion des risques liés à la fatigue au sein des Forces canadiennes (FC). Le présent document porte essentiellement sur la gestion de l’hygiène du sommeil et l’entraînement circadien et non sur la fatigue physique et musculaire ou la fatigue au niveau cellulaire. Les recommandations liées à la gestion de la fatigue sont basées sur les pratiques exemplaires déterminées par les plus récentes découvertes scientifiques ainsi que sur le dépouillement des politiques courantes des forces militaires d’autres pays, qui permettront au personnel navigant de donner le meilleur d’eux−mêmes. Le document comprend un ensemble de résumés indiquant ce qu’on sait et ce qu’on ne sait pas en ce qui concerne l’efficacité et la mise en œuvre des mesures de lutte contre la fatigue les plus couramment utilisées ainsi que les limites connexes. Une approche stratifiée est adoptée afin que la promotion du sommeil soit la première priorité dans le cadre de la gestion courante de la fatigue, suivie par l’intervention pharmacologique généralement approuvée. L’emploi des médicaments sur ordonnance permis par les politiques des FC sera suggéré uniquement en dernier recours. Le document est rédigé principalement pour la Force aérienne. Cependant, les recommandations générales sur la gestion des risques liés à la fatigue s’appliquent également à la Marine et à l’armée de terre, car elles sont aussi confrontées à la perte de sommeil à cause des changements de fuseaux horaires et de calendriers opérationnels.

Ces recommandations sont notamment destinées aux principaux utilisateurs suivants : les commandants, les instructeurs d'unité, les planificateurs de missions, les médecins militaires, les officiers de sécurité de l'unité, et tous les membres du personnel qui appuient les opérations. Ils sont invités à se familiariser avec les causes de la fatigue et les diverses options en matière de gestion des risques liés à la fatigue. Ce guide est considéré comme un document évolutif. Son contenu sera mis à jour à mesure qu'apparaissent de nouveaux renseignements techniques et de nouvelles données empiriques scientifiques.

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(U) Fatigue risk management recommendations

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